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QUARTERLY

OF THE

National Fire Protection Association

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EDITED BY THE SECRETARY

National Fire Protection Association.

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87 Milk Street, Boston, Mass.

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Western Factory Insurance Association.
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West Virginia Inspection Bureau.
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Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

H–8363.

Gibson House Fire and Union Trust Building.

Matches do not think with their heads.
When you use them your head has to do all the thinking.
Do the thinking! Put them out!
—E. T. Allen.

The Quarterly

Vol. 6 April, 1913 No. 4

The Seventeenth Annual Meeting. The forthcoming Seventeenth Annual Meeting of the Association, Tuesday, Wednesday and Thursday, May 13th, 14th and 15th, is to be held in New York City, in the auditorium of the Metropolitan Life Insurance Company, the building with the magnificent tower on Madison Square. The Metropolitan Life Insurance Company has graciously placed these quarters at the disposal of the Association for the three days of the meeting. The auditorium is of ample size to take care of any normal attendance.

The program this year is to have an unusual feature in an address by Miss Frances Perkins, Executive Secretary of the Committee on Safety of New York City. No woman has ever heretofore appeared upon our platform. The unusual character and accomplishments of Miss Perkins, and the direct relation of her work to matters of fire hazard, make her appearance at this time a matter of special interest and importance. Our members do not habitually bring the women of their families to our annual meetings. There is no reason, however, why they should not do so, and it is hoped that there may be a good attendance of women this year, especially at the session at which Miss Perkins is to appear.

Another interesting special number will be the address of David Knickerbacker Boyd, of Philadelphia, Chairman of the Committee on Public Information of our active member the American Institute of Architects. It was Mr. Boyd who planned the fire prevention campaign of the Institute so successfully carried out during the winter. The committee reports promise to be of unusual interest this year, and every effort is being made by the Secretary's office to induce the chairmen to furnish their reports in time for advance printing. The official program will be mailed to all members in advance of the meeting.

A National Fire Prevention Congress. A national Congress to consider the subject of the fire waste is being planned by the Fire Prevention Commission of the city of Philadelphia for assembly in that city next October. Mr. Powell Evans, Chairman of the Commission, is the leading spirit in this movement. He aims to secure uniformity of action respecting fire prevention methods by the various municipal departments of American cities. The work of the Philadelphia Commission is exceptionally well organized, and is being put forward with fine energy under the spur of Mr. Evans' personal direction. The Philadelphia Commission serves without pay, the city co-operating to the extent of furnishing office quarters; the Department of Public Safety co-operating in the work of regular inspections by members of the fire department. These plans have been worked out with such care by the Commission, and have already been given such sufficient trial as to indicate that other cities may hardly do better than follow Philadelphia's lead. At a public meeting held in Philadelphia in March, Mr. Evans said:—

The function of the Fire Prevention Commission in this city is to study and prepare expert advice for the use of the Department of Public Safety of Philadelphia. When the State or municipal government is clothed with the proper authority and the proper facts, it then becomes its duty through an adequate detailed organization to apply control to this problem and through the medium of adequate inspection to see that this control is positive and yields adequate results.

In this city we are moving along the line of the use of active firemen for a proper proportion of their time to inspect buildings and correct defects, primarily of housekeeping, while at the same time reporting on obvious structural deficiencies which will be matter for future correction. It has become apparent to this city's government and to this commission, as it has been apparent to me for years, that all of this sort of effort throughout this country is now measurably vague in form and purpose and almost entirely without reasonable common plan and co-operation.

The net commercial result of all this work in time will be to reduce the total national bill in life and property from destruction by fire and it should reflect itself in a lower cost for protection, or in the national insurance bill, as conditions better through coming years. Hence, while the control of Philadelphia fire waste is purely a local problem, the result of the control of fire waste through all these localities becomes in fact a national financial problem and, beyond any question, the people of the country, acting through their State and municipal governments and through trade associations of every sort, should combine in a common purpose and co-operative plan to bring about these results in a speedier and better way.

As soon as this commission began to study the work in something over thirty cities in this country, they found so many different purposes and practices as to make it clear that a national convention should be held in the near future on country-wide control of the present fire waste of something like one million dollars per day net.

In some cities some factors are being well cared for; others badly; others not at all. Even good methods have varied so widely in their practice as to show that there must be a possible compromise in these methods, best for all concerned that are now at work and best for those that will inevitably soon get to work.

This commission with the sanction of the present Philadelphia administration therefore is preparing an invitation for an American fire waste congress, to be held in this city somewhere about the middle of October next, to consider the control of American fire waste in all of its relations. Proper officials of the National Government concerned in national economic problems, State and municipal officers

touching the subject of fire prevention and insurance (including representatives of the fire prevention and protection forces), representatives generally of all great trade, civic, labor and business associations, and representatives of insurance organizations will be invited to attend. The whole subject of arson would be considered as well as the matter of annual occupancy licenses of buildings. The proposal of the consolidation of all inspection agencies in cities into a central inspection bureau would be investigated as well as the best methods of public education on the whole matter. The program would necessarily be so broad and complex that papers and discussion following them would necessarily be limited to subjects and hours defined by the controlling resolutions which would open the congress.

The program as outlined by Mr. Evans would include a consideration of the location of buildings with reference to the exposure hazard; building construction, including city building codes; protection in all its phases; equipment, occupancy and management or housekeeping.

* * * * *

Inspection Results in Montreal. The experience of a number of cities with inspections by the rank and file of their fire departments has now been sufficient to indicate the beneficial results of such inspections, and to encourage the hope that the fire waste may eventually be substantially reduced through this agency. One of the most interesting tabulations of figures that have come to us has been sent in by Chief Tremblay, of the Montreal, Canada, fire department, showing result of the inspection work of the department during the past seven years, which period includes two years during which such inspections had not yet been begun. Following are the figures:—

Year.	Pop.	Number of Alarms in congested District.	Total number of alarms for the City.	Fire losses for City.
1906	320,000	217	1,613	81,947,600
1907	360,000	239	1,739	3,500,000
1908*	373,000	163	1,689	989,000
1909	389,837	117	1,759	846,385
1910	456,000	89	2,143	1,080,000
1911	466,197	77	2,717	1,045,000
1912	530,437	62	2,665	1,160,000

The inspection work in Montreal has so far been confined to the congested district, and it will be noted that the number of alarms in this district has remarkably declined since inspection was inaugurated in 1908. The heavy losses in 1907 led Chief Tremblay to appeal to the Quebec Legislature for an enabling act, which was granted in December, 1907. This act was confirmed for Montreal by the municipal council in April, 1908, but regular inspections were not started until the fall of that year. The number of alarms in the congested district contrast interestingly with the total number of alarms for the entire city appearing in an adjoining column. The fire losses for the whole city, which are also shown, emphasize the fact that the fire loss is not necessarily directly related to the number of

* Inspections were started in 1908 for the three last months only.

alarms. Notwithstanding this fact, it is obvious that a reduction in the number of alarms must, in the long run, substantially reduce the total losses, although for a year or two no direct indication may be exhibited. The number of alarms in the business district, steadily reduced by the inspections, as shown by the above table, proves the contention of fire prevention engineers, that a large majority of our fires result from bad housekeeping.

* * * * *

Ohio's State Building Code. The pioneer work of Ohio in the matter of a state building code is attracting more and more public attention as the general subject of building codes is being agitated throughout the nation. The Ohio experiment does not follow conventional lines. The State Insurance Board of Texas has produced an excellent abridgment of the building code of the National Board of Fire Underwriters. Before it becomes operative, however, it must be sanctioned by the city councils of individual cities. It is really a city code advised by the state. In the case of the state building code of Ohio, a portion of which has already been adopted, the idea is to provide a state code as a code of minimum requirements to apply generally over all towns, cities and villages in the state. This measure is not designed to prohibit such cities as Cleveland and Cincinnati from publishing their own local building codes, but, of course, nothing in the latter under the regulated minimum of the state code will be permitted. As an illustration of how the Ohio proposed state code will eliminate ordinary structural defects, we have received from our member Mr. Chas. H. Patton of Cleveland an interesting commentary upon the application of the code to such a building as was described under fire No. H-8128, illustrated in the January QUARTERLY. In connection with the building code the state maintains a building code commission. The consulting architect of this commission was given a copy of the fire report above mentioned and after a study of the same made the following comment:—

I have applied the tentative State Code to the building you describe and with satisfying results which are as follows—which proves that your observations are all covered by the tentative State Code:

This building should have been of fireproof construction. (See Part 2, Title 7, Section 2.)

The floor space in each story should have been subdivided with one fire stop wall. (See Part 2, Title 7, Section 4.)

All elevators and stairways should have been enclosed. (See Part 2, Title 7, Section 12 for stairways, and Part 8, Title 2, Section 16 for elevator enclosures.)

The building should have been provided with sprinklers. (See Part 2, Title 7, Section 25.)

The enclosed stairways would have provided access to the building for the firemen.

The heavy expense of publishing ordinances in small cities is often a bar to the passage of a building code. In such cases the operation of

a state code similar to that of Ohio would achieve an equally desirable result and the matter of following the lead of Ohio in this work may well be profitably discussed in all the states.

* * * * *

Automatic Sprinklers as Life-savers. The behavior of automatic sprinklers in the extinguishment of fires is too well known to our members to require comment. Their value as life-savers, however, was brought to public attention by many engineers commenting upon the Asch Building disaster, nearly all of whom ventured the opinion that had the Triangle Shirt Waist Company equipped its quarters with sprinkler protection the deplorable loss of life would not have resulted. Two reports have been received by us, one from the Rockford Paper Box Board Company, and the other from the Atlas Portland Cement Company of Northampton, Pa., covering accidents in which sprinklers played an important part as life-savers. In the first named plant, from some cause or other not determined, the cylinder head was blown from a 500 horse-power Corliss engine. The engineer at the time was standing at the throttle. The steam rushed out in great volumes but the heat of the same instantly operated several sprinkler heads, precipitating a shower of water. The engineer was badly scalded but the sprinklers saved him from certain death. The similar accident at Northampton, Pa., occurred in a room containing six or seven employees. Describing the accident the general superintendent writes:—

> Suddenly, and without warning, the end of a six-inch steam pipe, carrying about one hundred pounds of steam, blew off. The room was instantly filled with steam, but almost instantly every automatic sprinkler in the room opened. Between seventy-five and one hundred sprinklers went into action. All of the men were more or less scalded but none of them very seriously. One man fell into a flywheel pit, and was so seriously injured that he died a week or so afterward. The others recovered in a very short time. If it had not been for the sprinklers, there would have been absolutely no chance for any, as it was necessary to get to the main boiler stop valve before the steam could be shut off. I saw the room an hour or two after the accident, and there was not a spot in it that was not thoroughly soaked with water. The men remained on the floor of the room until after the steam had been shut off and it was possible for outside help to get in.

Motor Spirit: the New Fuel. A substitute for gasolene, three cents a gallon cheaper and with 25 per cent more power has been brought out by the Standard Oil Company. Motor spirit is the name of this new fuel. A recent number of *The Automobile* gives this description of it:—

> It resembles gasolene very closely except that it is yellow in color and has a very pungent odor. It has a slightly greater range of boiling points than has gasolene, its minimum point being somewhat lower than that of the older fuel and its maximum slighter. This allows a motor to be started as easily or more easily with this fuel than with gasolene. In gravity it is somewhat heavier than gasolene, ranging from fifty-two to fifty-five degrees Baume, while gasolene ordinarily runs from fifty-eight to sixty degrees.
>
> Motor spirit is an additional by-product of petroleum to any which has been

obtained heretofore, that is, in addition to the quantity of gasolene which formerly had been obtained from a given amount crude, almost the same quantity of motor spirit is obtained. This has been made possible by an invention of W. M. Burton and patents for the process have been granted only since the first of the year. It is stated that the yellow color and the offensive odor could be done away with by a process of deodorizing and decolorating similar to that employed with gasolene, but such refinement would make the product just as expensive as the older fuel. The use of motor spirit requires a slight adjustment of the carbureter as it requires more air for combustion than does gasolene. Although the new fuel has the very desirable advantage of lower cost and increasing economy in miles per gallon, it has in its present state several disadvantages which may militate against its widespread adoption, particularly for the use in pleasure cars. In fact the Standard Oil Company is not offering motor spirit as a pleasure car fuel, but only as a fuel for motor trucks and for stationary engines. One of the chief disadvantages, particularly where cars are to be driven on the boulevard, is that the exhaust is in the form of a white smoke, quite similar to that due to an excess of oil. It is stated, however, that by reducing the quantity of oil, smoking is to a great amount overcome; in fact, it is found that quite a little less cylinder oil may be used safely with motor spirit than it would be safe to use with gasolene. There is a slight carbonizing of the cylinders similar to that found when an excess of oil is used, but this deposit is soft and a weekly application of kerosene has been found to keep the cylinders clean. The fuel, although giving initial explosions on starting and letting the motor run for several minutes, will seem to choke up occasionally until the manifold gets warm. This is due to the condensation in the manifold which seems to be much more pronounced than when gasolene is used. With the short intakes, however, the difficulty could be avoided. The odor of motor spirit, though unnoticeable in open air in small quantities, becomes somewhat pronounced when a tank of the fuel is kept in a closed room. For motor truck work where there is little objection to smoking and where the odor is not a fault, motor spirit will have its greatest field. The great consumption of gasolene by commercial vehicles has been threatening the available supply for some time and has been advanced as a chief reason for the increase in price of gasolene. The new fuel, however, should do very much to relieve this situation. Motor spirit has been under test by the Standard Oil Company in its own pleasure cars and trucks for several weeks and has proved its superiority of efficiency.

The description of this new fuel indicates that it is fully as hazardous if not more so than gasolene.

* * * * *

New York Factory Fire Perils. Timed to commemorate the second anniversary of the Asch Building fire—in which 147 employees of the Triangle Waist Company lost their lives on March 25, 1911—the Committee of Safety of the city of New York made its annual report public on that date. Calling attention to the influence exerted in behalf of the creation of the Bureau of Fire Prevention and the appointment of the State Factory Commission, the report adds:—

The committee has made studies of fire conditions in 2,365 factories in the city, and its conclusions are therefore illustrative of actual conditions. These specifically show the common occurrence throughout the city of defects and dangers similar to—sometimes worse than—those existing in the Asch Building. Investigation of 433 buildings showed the stairways to be unsafe in over one half. In three fourths of the buildings the emergency exits, outside fire escapes and outside stairs were unsafe. About fifty per cent had doors which opened inward or were obstructed.

A special study of the number of occupants in relation to the capacity of exits was made in fireproof loft buildings in a district comprising fifteen blocks—bounded by Fifth and Eighth Avenues and Twenty-third and Twenty-eighth Streets. There were found to be 221 factories, employing 5,650 persons, in this district in which the number at work was greater than the emergency capacity of the exits.

Forty-three per cent of the total number (2,432 working people) are unprovided with exits in case of fire. Eighty per cent of the buildings presented a condition in which the discrepancy between the exit capacity and the number of occupants was glaring.

This kind of overcrowding, which was one of the main causes of death in the Triangle fire, still offers a menace to life in New York factories. The dangers in the older buildings on the lower east and west sides, which are non-fireproof and in which proper precautions are conspicuous by their absence, lie chiefly in the fact that the exits are of such unsafe construction and maintenance that persons using them in time of fire are not protected from flames, panic or suffocation.

This is not a reassuring report made by the Committee of Safety. Do the citizens of New York need another Asch Building horror to furnish the spur to action, the need of which has been made so clear?

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A Correction. Through oversight the loan of the illustration appearing on page 329 of the January QUARTERLY was not credited to the *Electrical Review and Western Electrician* through whose courtesy we were permitted to use it.

A Gentle Hint.

By the Stove-Pipe Committee.

If you're on a railroad crossin' when a train is near at hand,
And you listen to the engine whistle blowin',—
It's a sort o' terse and timely criticism of your "stand,"
And a warnin' that you'd better be a-goin'.

If you've ever held a rifle with its muzzle to your eye,
And you've noticed that the bloomin' thing exploded,
You can make a memorandum when you reach the By-and-By,
That the gun in question probably was loaded.

If you're turning into ashes in the middle of the night,
And the family is goin' up in smoke,—
While burnin' you can fill your heart with spasms of delight,
By recallin' every dirty chimney joke.

Burning of Medford Opera House.

The Hazard of Wooden Buildings.

The Association is indebted for the above interesting photograph to member Frederick H. Cowles, of Medford, Ore. The Opera House caught fire at 5.05 P. M. The stage fell in at 5.15 p. m., and the building was destroyed at 5.25 p. m. Its rapid burning was due to its construction, shown in the cut. The ignition of the shingle roof of the adjoining building is well illustrated.

For the benefit of members interested in fire insurance, Mr. Cowles states that the sign on the building with the shingle roof, "Bought and Paid For," does not refer to the building, but is the name of a play.

Public Education.

The most useful and far-reaching contribution to the campaign of public education in fire prevention during the winter was made by our active member the American Institute of Architects. Secretary Wentworth appeared as a speaker at the annual convention of the Institute on December 10th in Washington, D. C. This was the first occasion on which the Institute had made a special topic of fire prevention, and the speaker was received with an interest and enthusiasm which indicated that the architects were much more alive to the matter of fire prevention than had been commonly assumed. Upon the initiative of Mr. D. Knickerbacker Boyd, Chairman of the Institute's Committee on Public Information, it was decided that a special speaking campaign should be arranged for Secretary Wentworth among the various local chapters of the Institute throughout the nation. The limited time, however, which the Secretary of the N. F. P. A. could devote to such a campaign before our annual meeting made it impossible to follow the original suggestion of Chairman Boyd that all chapters in the country be visited. A selection was therefore made by him of the chapters east of the Missouri river, including special meetings in North and South Carolina, where independent architectural associations are in existence having no direct connection with the Institute.

Owing to the unusual energy and fine executive ability of Chairman Boyd, within a month of the annual convention at Washington meetings had been arranged under the auspices of the architects in the following cities: Brooklyn, N. Y., Newark, N. J., Pittsburgh, Pa., Buffalo, N. Y., Cleveland, O., Detroit, Mich., Indianapolis, Ind., Chicago, Ill., Louisville, Ky., Cincinnati, O., St. Louis, Mo., Kansas City, Mo., New Orleans, La., Columbia, S. C., Raleigh, N. C., Baltimore, Md., Philadelphia, Pa.

The majority of the meetings were in the form of evening dinners to which city officials, the heads of commercial organizations and other interested persons were invited. In a number of cities, however, such as Pittsburgh, St. Louis, Kansas City and New Orleans, the local chapter united with other bodies in a joint meeting. In certain cities additional meetings were arranged, as, for instance, in St. Louis, where Mr. Wentworth appeared at noon at the luncheon of the City Club, the principal meeting being at the Mercantile Club in the evening, where a dinner was given by the architects and local association of Credit Men. There were some five hundred persons in attendance at this meeting. St. Louis happened to be the one city omitted from the itinerary of Secretary Wentworth and Vice President Meek last season.

In a number of cities public officials appeared as presiding officers. Mayor Blankenberg presided at the meeting in Philadelphia, Insurance Commissioner James R. Young of North Carolina at the meeting in Raleigh, and Insurance Commissioner F. H. McMaster of South Carolina at the meeting in Columbia which was held at the University of South Carolina. In Pittsburgh the newly elected mayor was present, and immediately at the close of the noon meeting, which the architects had held in conjunction with the Hungry Club, arranged a meeting of all city officials at the City Hall, at which the Mayor himself presided, and where an opportunity was given Secretary Wentworth for a two hours' conference with the heads of the city departments. The Director of Public Safety at Cleveland, being present at the evening dinner of the architects at the Hollenden Hotel, arranged a meeting at the City Hall for the following Friday, when Secretary Wentworth returned to Cleveland on invitation of the mayor to address the city officials at a specially called meeting in that city.

In New Orleans, where the architects had already taken an active interest in fire prevention matters even to the extent of saving by their influence the Louisiana Fire Prevention Bureau from annihilation by the Louisiana Legislature, Secretary Wentworth's message was received with great enthusiasm. At the dinner given in his honor he was unanimously elected an honorary member of the Louisiana Chapter of the Institute. The following day a luncheon was given by the Louisiana Society for the Reduction of the Fire Waste, at which President Cunningham presided, and which was attended by the new state fire marshal and other state and city officials. This organization, which is one of our active members, also conferred honorary membership upon Secretary Wentworth. The meeting at Columbia, S. C. was attended by the President and faculty of the University, and at the meeting in the Auditorium at Raleigh, N. C., the entire fire department was present in uniform, with all the fire apparatus lined up in the street in the event of a possible fire alarm.

It would be difficult to estimate the real value of this campaign on the part of the architects. The American Institute has for many years been an active member of the N. F. P. A., but until the present year no opportunity had been provided for bringing the work of the Association directly before the rank and file of the Institute. The members of the local chapters are men of unusual character and influence and their direct and constant relations with the building departments of the cities in which they reside afforded Secretary Wentworth an admirable approach to the officials of these departments. The consideration of the subject by the architects themselves was enthusiastic and straightforward, and it is obvious that not only were our relations as an Association with our valued active member cemented by uniting in this important work, but many friends were made both for the Association and its cause among the individual architects of the various cities visited. The chapters in St. Paul, Denver, and the cities of the Pacific Coast are desirous of aiding in the work and are looking forward to the season in which Secretary Wentworth will again visit the far West.

Besides the speaking tour under the auspices of the American Institute of Architects the Secretary has filled numerous speaking engagements during the past quarter, among which were the following: Providence, R. I., Conservative Club dinner January 24th; New Haven, Conn., annual banquet Board of Fire Underwriters January 29th; Cleveland, Ohio, Insurance Institute dinner February 14th; New Orleans, La., Society for the Reduction of the Fire Waste, luncheon, February 22d; Hartford, Conn., Insurance Institute annual banquet February 27th; Erie, Penn., annual meeting Chamber of Commerce March 18th; Syracuse, N. Y., monthly luncheon Chamber of Commerce March 20th; Waterbury, Conn., annual banquet Waterbury Board of Fire Underwriters March 27th; Middletown, Conn., Twentieth Century Club dinner March 28th; Norwich, Conn., annual banquet Board of Trade March 31st. Boards of trade and chambers of commerce are becoming increasingly interested in the subject of the fire waste, requests from them for speakers being frequently received.

* * * * *

Our active member, the National Association of Credit Men, does not fail to make frequent contributions to the cause through some of its local associations. The co-operation of the St. Louis Association with the local chapter of the American Institute of Architects made the February fire waste meeting at the Mercantile Club in St. Louis a memorable one. The Engineers' Club of St. Louis and the St. Louis Architectural Club also co-operated.

Mr. E. M. Underwood, of the Portland, Ore., Association of Credit Men, appeared as a speaker before the Ad. Club of that city on March 5th with a lecture on fire prevention, illustrated by lantern slides. Mr. Underwood had quietly obtained photographs of hazardous places in the business center of Portland and exhibited the same at the meeting. They showed heaps of inflammable rubbish behind wooden buildings, alleys filled with rags, paper and decaying wood, and filth holes that constitute a menace to health, presented in such convincing manner that the Ad. Club members were moved to an appeal for more care and security for property. Mr. Underwood said:—

"In the effort for civic cleanliness and safety we must insist upon individual responsibility. The city will be just as clean, just as moral and just as good as its individuals. We should have a law making the occupant of a building responsible for a fire occurring in that building. If a fire gets out of that building into some one else's property he should be held responsible for that, especially if it could be proved that the fire started as a result of his negligence and carelessness."

We learn through Mr. Chas. E. Meek of our Executive Committee that Mr. Underwood was also the principal influence in the passage of a bill by the Legislature of Oregon, which has been signed by the Governor, requiring the teaching of fire protection in the public schools of the state.

J. Albert Robinson, Superintendent of Fire Records of the N. F. P. A., filled several speaking engagements during the last quarter, appearing at the annual banquet of the Lowell Board of Underwriters of Lowell, Mass., on January 8th; at the annual banquet of the Underwriters' Association of New Britain, Conn., January 22d; at the High School and before the Woman's Club of Fitchburg, Mass., on March 19th; and at the meeting of the Board of Trade, Gloucester, Mass., on March 21st. Excellent newspaper reports were given. At Fitchburg Mr. Robinson visited the fire department headquarters for an informal talk to the members of the fire department.

* * * * *

Our valued Philadelphia member, Mr. Powell Evans, appeared as a speaker with Secretary Wentworth at the meeting in Philadelphia March 7th, planned by the Architects. Mr. Evans, with the assistance of others interested in the work, has developed a remarkably efficient organization in Philadelphia in the Fire Prevention Commission of the Department of Public Safety in that city. Mr. Evans recently issued a letter regarding the work of the Commission in its efforts to reduce the fire danger and loss, in which he says:—

"The situation in Philadelphia gives peculiar importance to the work of this commission, because Philadelphia, from its size, is a very important municipality in the first place; in the second place the municipal government of Philadelphia is at present conducted entirely on an efficiency basis, so that good rules can be worked out and put into effect: in the third place, there is a clear run of this government for the next three years, so that rules which are enforced can be made to show conclusive results.

"The mayor and director of public safety are standing squarely behind this commission in their work, and under the municipal charter of Philadelphia—called the Bullitt Bill—and the City Fire Marshal Act, passed by the last Pennsylvania legislature, there is ample power to control the fire situation."

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The Ontario Fire Prevention Association has been organized as the result of the fire prevention campaign carried on during the winter by our active member the Canadian Manufacturers' Association. A number of our influential associate members are identified with the new association, among the same being Percy Robertson, Dean Fernow, E. P. Heaton and J. B. Laidlaw. Much good work is expected from this new body.

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President H. L. Phillips of the N. F. P. A. delivered an address before the Insurance Society of New York on Tuesday evening, January 28th, on the subject of the work of the fire insurance inspector. President Phillips dwelt especially upon the mental attitude of the inspector toward his work, indicating that enthusiasm and devotion to the work in hand may frequently overcome defects of technical education. President Phillips illustrated his talk with tales of interesting adventures of some of the inspectors of the Factory Insurance Association of Hartford, of which he

is manager. He closed his remarks with Captain Stratton's definition of what an insurance inspector should be. These were some of the qualifications which he said were necessary: A man in perfect health; a man who never worries; a man who never rests; an expert architect; an expert construction engineer; an expert fire protection engineer; an expert chemist, and an analogist of fire hazards and causes, possessing a complete knowledge of all manufacturing processes, a thorough and accurate knowledge of rates, forms and policy conditions; an expert adjuster, a diplomat and a prize fighter.

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Our Rockford member, Chief Frank E. Thomas of the Rockford Fire Department, made an interesting address at the annual meeting of the Illinois Firemen's Association in January upon the subject of the practical use of the automobile fire engine. Chief Thomas presented figures from the bookkeeping in his own department, showing that during the twelve months of 1912 the saving of the motor fire engine over the cost of operating the steam fire engine was nearly $1,500. Among other things Chief Thomas said:—

"In my estimation, the practical use of automobile fire apparatus demands that the construction be heavy enough to avoid troublesome breakages and the delays and the dangers which are incident. I think the mistake of using so called "light apparatus" for heavy service is doing much to disturb confidence in auto fire apparatus. This feature is on par with the indifferent attention given by incompetent handlers, and between these two, or the two together, are bred the greater percentage of those things which go to give auto fire apparatus a backset on grounds which fundamentally have no true basis at all.

"My own experience is such also that I do not regard the pneumatic tire as being essential to the auto fire engine. In fact I do not even consider it desirable. The solid tire is capable of carrying weights which make husky construction possible throughout. The upkeep of the solid tire is less; it represents a gain in so far as safety and certainty are concerned, and moreover I can say that, if the chassis are fitted with a good form of spring suspension, the riding on solid tires is far from being rough. I feel free to grant that solid tires have a lower limit of speed. In Rockford, however, we attain speeds as high as thirty-five miles per hour on our solid tired auto fire engines, which, according to my notion, is plenty fast for an apparatus approximating seven tons in total weight."

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Former President W. H. Merrill gave an interesting talk on the development and efficiency of electrical inspection before the Electric Club of Chicago at its noon luncheon at the Hotel Sherman on February 27th. As manager of the Underwriters' Laboratories Mr. Merrill reports a plan to extend the present buildings of the Laboratories to provide additional space for hydraulic and chemical laboratories and offices. Another interesting note in connection with the Laboratories is the addition to the Laboratories' Council of Dr. S. W. Stratton, Director of the Bureau of Standards at Washington.

The growing importance and extent of the work of Underwriters' Laboratories in connection with the general movement for reduction of the

fire waste in America, together with some work in this field which the Government has outlined, make Dr. Stratton's appointment to membership in the Laboratories' Council a particularly happy one at this time. It will be viewed with favor, especially by all advocates of uniformity and efficiency in fire protection engineering practice.

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Mr. John A. Brown, our member at Glen Ridge, N. J., who has long shown a live interest in fire prevention, addressed the Women's Club of Glen Ridge January 24th on Fire Prevention in the Home. After outlining the extent of the fire waste of the country Mr. Brown began with the cellar and its hazards, ascending to the attic, and outlined the dangers of all the domestic processes and hazards found in the ordinary home. Mr. Brown is one of our many devoted associate members who are continually at work within their local spheres of influence to educate their friends and neighbors.

* * * * *

Our active member the American Institute of Architects has abandoned its quarterly magazine and has undertaken a monthly journal which is issued from its headquarters in Washington. Beside a record of the proceedings and activities of the Institute and its various chapters it is devoted to the dissemination of information on the general subject of architecture. It is most beautifully printed and does our distinguished active member much credit. The work of the new committee on Public Information of the Institute, directed by Mr. D. Knickerbacker Boyd of Philadelphia, is already placing the Institute in the front rank of public-spirited organizations. The unusual energy of Mr. Boyd, his personal popularity, and his unselfish devotion to the Institute have led him to undertake to prepare a regular weekly section for the *Philadelphia Public Ledger* on City Planning and Architecture. The *Public Ledger* is fortunate in securing, as the editor of its new section, so able an assistant as Mr. Boyd.

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Mr. F. M. Griswold, Chairman of our Committee on Standard Hose Couplings, is to appear as a speaker at the annual convention of the American Society of Mechanical Engineers in Baltimore, Md., on May 23d, and is to present at that time for their consideration the matter of the official endorsement of the National Standard hose coupling specifications. Our Association has no member who has made a greater contribution to its work or is more devoted to our cause than Mr. Griswold.

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On March 4th Mr. H. W. Forster of Philadelphia addressed, for the seecond time, the Engineers' Society of Western Pennsylvania at Pittsburgh. Mr. Forster's subject was "The Fireproof Building, Its Advantages and Its Weaknesses." The paper was a valuable summary of what is expected of fireproof buildings. of the showing which they have made, and of the existing defects in design and construction. He

also indicated proper remedies for such defects. Among other things Mr. Forster said:—

> The degree of intelligence which will cause a man to erect an important fireproof building, filled with combustible material, and subject to exposure, without protecting the exterior openings with wired glass windows, is about on a par with that which would lead a man to build a safety deposit vault and provide it with a wooden door.

Mr. Forster also spoke in December at the annual meeting of the American Warehousemen's Association. Our active member the Warehousemen's Association gives frequent attention to matters of fire protection, two of our members besides Mr. Forster having spoken at the conventions of this body during recent years; viz., Mr. C. H. Patton of Cleveland and Mr. C. A. Hexamer of Philadelphia.

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The Chicago, Rock Island and Pacific Railway Company issues a magazine the object of which is to maintain a spirit of co-operation among the employees. The Rock Island road is represented in our associate membership and Mr. P. Hevener, Assistant Supervisor of Insurance for the company, has sent us the following extract from an article prepared by him for a recent issue of the magazine:—

> I do not believe it is any exaggeration to say that the Rock Island numbers more actual "fire fans" among its employees than any other railroad in the West; by "fire fans," I mean employees who are deeply interested in the general subject of fire protection and prevention, and do not hesitate to go considerably out of their way to remedy, or report defective conditions which might lead to disastrous fire losses. This common interest and co-operation with the insurance department's system of inspection has accomplished results of which we all may justly feel proud.
>
> The work of our terminal fire brigades is especially worthy of commendation; the intelligence and familiarity with local conditions, shown by our "fire laddies," in weekly practice, and while actually fighting fires, has been thoroughly demonstrated, as will be shown by statistics appearing later in this article. We have 328 men who are making regular practice drills every week in order to be prepared to cope with an emergency. During the past fiscal year these 328 men extinguished fires to the number of 283 with company fire apparatus, in connection with property having a schedule valuation of $5,101,195, with resulting loss of only $28,570.44.
>
> Our total fires for the year numbered 462, with a loss of $89,944.39, or by far the best record we have ever made.

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One of our New York members, Mr. Henry A. Fiske, who, while in the employ of the Phoenix Insurance Company of Hartford, founded the QUARTERLY Magazine of the National Fire Protection Association, addressed a meeting of our associate member the Insurance Society of New York at its meeting on April 1st on "Automatic Sprinkler Installation and its Relation to Various Occupancies." Few members of the Association are better posted in automatic sprinkler practice than Mr. Fiske.

Vampires Three.

By O. H. Roesner.

WIND SPEAKS:

I speed the sailor and whirl the mills
  And make a harp of the tree;
I waft the showers that bring the flowers
  To dapple each dale and lea.
But woeful the ways that in hunger I choose
  To blast with my awful breath,
For I shatter and wreck and naught may check
  My terrible dance of death.

WATER SPEAKS:

I bear the vessels and turn the wheels
  And give the desert the rose.
I ripple in rills and leap down the hills
  Or lie in a glassy repose.
Though I do man's hest without spoil or meed
  Cooped up in river or lake,
When I surge in wrath from my wonted path
  Wild ruin I leave in my wake.

FIRE SPEAKS:

I am vassal of man and I do his will
  In many a wondrous way.
If he chain me sure I am fain to endure
  His mastery night and day.
But should I escape from my dungeon red
  By charring the bolts and bars,
I chasten my master with hell's disaster
  And flaunt my head to the stars.

ALL THREE SPEAK:

Aye, puppets are we of the tyrant man
  So long as our passions slumber;
But woe to the day that we make him our prey—
  Ah, who may our victims number!
For harpies relentless we mangle and tear
  Our puny lord and his city:
Then mock at his moans and jeer at his groans,
  Devoid of mercy or pity.

The Fireman as an Educator.

By Julius Hyman.

Slowly but surely it has been borne in upon the mind of the reformer that unless there is an intelligent, active, sensitive, and responsive public opinion to back up the enforcement of laws—"sanction" the publicists call it—then all legislation is of no avail for corrective purposes. It only clutters up the statute books, and proves a positive evil in itself, since it gives rise to all kinds of official corruption as the result of sporadic, inadequate, or impossible efforts to enforce such laws. Official enforcement never rises higher than the community's demand. Emerson says that the gas lamp is the best policeman, and we are slowly learning that an aroused public sentiment is the best enforcer of the law. How to create that general sentiment, and then how to keep it actively alive and acutely alert is the problem facing those directing the municipality. Eternal vigilance is the price of law enforcement, no less than of liberty.

The terrible lesson of the Asch Building fire in Washington Place, where the lives of 145 factory operatives, mostly girls, were lost, has been learned. The public is aware that even in the most fireproof building, the inmates cannot hurriedly get out at once haphazardly. In the control of masses of people, such as are found in modern high buildings, discipline is absolutely necessary. The co-operation of the governed mass is as essential for safety as is intelligent and directive control by leaders.

In our public schools to-day we have the perfection of discipline as regards the moving of large numbers of individuals as a unit. Our public schools have not been the victim of an accident owing to fire since 1884. In public school 62, 4,000 pupils, ranging from five to sixteen years of age, are dismissed in perfect order in three minutes, without any symptoms of unnecessary hurry or disorder, and arranged on the nearby sidewalks in perfect array—all this in one of the most crowded neighborhoods of the city. Such a scene may be witnessed daily in New York City in any one of the 550 schools, which house a population of 750,000 pupils. This is due to the perfect discipline that is maintained at dismissals in our public schools. We have this agency for popular education at our immediate command. Why not utilize it for the enlightenment of the public in the everyday affairs of life?

In late years the teaching of certain subjects has become rational and practical. A few years ago the average pupil in the geography class could recite, from memory, all the boundaries of far distant Baluchistan.

To-day, instead, that same pupil studies local geography, and is enabled to name the bodies of water adjacent to Manhattan Island. In history that same pupil could give, from memory, the names of all the battles, and the commanders on both sides, of the second year of the French and Indian War. To-day he recites on the method of electing his local Assemblyman, and learns about the Board of Estimate, and what the Municipal Budget means to him. In classroom physics, why cannot the grammar school pupil learn about combustion and simple methods of extinguishing fires, instead of trying to solve abstract problems in simple mechanics, and acquiring a very fragmentary knowledge of a number of subjects embraced under the general head Science.

The New York fire commissioner has posted in all the factory buildings in the city large signs printed in four or five foreign languages as well as in English, stating rules and regulations concerning the prevention of fire. This is intended to reach the factory workers. The unfortunate part is that of those whom it is most intended to affect, a very large number cannot read, not even in their native tongue. To a great extent this effort is wasted. None so blind as the illiterate. Has not the commissioner started his campaign of education from the wrong end? Could not that magnificent avenue for public appeal, the public schools, be utilized far more effectively for accomplishing his purpose?

Under the combined direction of the Bureau of Fire Prevention and the Board of Education, a syllabus should be drawn up outlining topics for popular instruction as regards fire prevention and control, viz.—

(1) Duty of the householder to plan method of escape for his family in case of emergency.

(2) Duty of inspecting fire escapes, halls, stairways, windows, chimney flues, scuttles, from cellar to garret, to see if they are kept clear and unobstructed, and duty to notify proper city department in case they are not.

(3) The best place to keep inflammable materials, as matches, oils, oil-soaked rags, etc., in the home.

(4) What to do in case of fire.

(5) The necessity of keeping cool for the safety of one's self and others.

(6) The use of woolen head coverings and wet towels to avoid inhalation of smoke and flame.

(7) How to find the window in a densely smoke-laden room—the *vade mecum* of every fireman.

(8) The dangers of back drafts due to open doors.

(9) What to do until the engines come.

(10) Home cleanliness as an important preventive of fire.

(11) Simple methods of resuscitation, and how to treat burns.

(12) How to use fire appliances, etc.

Information on these points can be found by the layman, carefully buried in annual departmental reports. Perhaps a more general knowledge of such practical information would help lessen the terrible fire losses that characterize our American civilization. The annual property loss in the nation last year was $225,000,000. In New York City it amounted to $10,000,000. These figures are a standing indictment of our recklessness and indifference in building construction. In every school

the day's exercises are preceded by a general assembly beginning at 9 o'clock and lasting about half an hour. The exercises consist of songs, recitations, patriotic selections, etc. Too often a large part of the time is taken up by the principal's idle reminiscences of "What I did when I was a boy." Could not a portion of this time be put to practical purposes by setting aside one morning in the week for a short talk on fire control and instructions by a uniformed official of the fire department? In every fire house there are at least one or two young firemen, clean cut, athletic, intelligent looking, who would make attractive figures in their uniforms on the school platform before the assembled pupils. Some of these men have had full grammar school education; some even higher training. These men could very easily be coached for these simple talks to the pupils in the elementary schools. By the aid of the syllabus, outlining topics to be touched upon in these short talks, the lecturer could make very interesting and instructive points on fire prevention in the home and shop, what to do in emergencies, etc. This new field of effort for the fire department would have a marked effect upon the *esprit de corps* and personnel of the department by giving it a wider and more useful field of activity, and consequently enhanced standing in the community.

This plan must be developed under the direct auspices and control of the fire department. The fire uniform would emphasize incalculably the value of the lecturer's remarks. One need not be a student of Le Bon's *Psychology of the Crowd*, and other books dealing with mass control, to know what a uniformed official means to the man in the street. How much more weight it carries with the impressionable child need not be dilated upon here. Every parent is familiar with the child's daily recital of that dogmatic, "Mamma, teacher said to-day that we mustn't," etc. Think what an effect the fireman's talk would have upon the assembled family's discussion of the day's events at the supper table evenings. It could be so arranged that the uniformed fireman-lecturer cover the four or five schools in the immediate neighborhood of his fire house. In the course of a month every one of the four or five local schools might be visited by him for a short talk. During the year from six to ten talks will have been delivered to the vast army of school children in Greater New York. To-day there are 750,000 children of school age. Allowing 150,000 as being of too tender an age to appreciate such instruction, think what it might mean to have 600,000 earnest enthusiasts doing missionary work for such a cause every school day in the year—a tremendous living power for good. And think what New York's successful example would mean to the whole country and her 20,000,000 enrolled pupils! Detailing one man mornings for this instruction would not seriously interfere with routine work in the local fire station, and would perhaps make for a better and closer acquaintance between the station and the people living in the immediate neighborhood, to the mutual advantage of both.

Think what this daily campaign of education could effect by keeping the public conscience constantly tender and alive on a topic so vital as fire prevention, by having that topic discussed periodically in every home

by the mothers and the children. Think what this would mean in those homes where the elders cannot read the list of instructions now being so conspicuously but ineffectively displayed in the factory buildings. Think what this would mean even in the average American home, where the parents, although intelligent, have never had the occasion or necessity to inform themselves on so vital a subject that may at a moment's notice be violently thrust upon them. How many tenants of apartment houses have outlined clearly what they would do in a fire emergency? How many have ever made a trip to the roof to familiarize themselves with that means of escape? In how many private dwellings has the owner made definite provision for taking care of his dear ones in case of a fire panic? How many of them are familiar with the vertical ladder on the top floor leading to the roof scuttle? How many understand the working of the fire extinguisher and could effectively handle it at a moment's notice? The project as outlined will not entail any increase in the departmental budget, a most desirable virtue nowadays with the Board of Estimate. To-day the New York fire department has 6,600 members and spends $8,600,000 annually. Without any additional expenditure, the department's usefulness to the citizen would become immeasurably increased. Think of the value of bringing the fire department into direct home contact with every family in Greater New York to-day. The citizen comes in contact with the fireman only in cases of accident or misfortune. A visit of the department is synchronatic with danger, disorder and destruction. By this method the department and its objects would become an active, living, constructive entity to him. The benefits of such an acquaintance are obvious.

The health department nowadays comes into direct contact with the schools by means of the daily visits of the doctors and nurses, and the required reports of contagious diseases. Why should not the fire department do the same? A state law compels the systematic teaching of the dangers of the use of alcoholic liquor. Surely the prevention of a possible and more positive form of combustion ought to be provided for!

The schools are slowly but surely becoming the centers of social activities. The public has only lately realized that the tremendous investments that the generous American public has made in the equipment of the educational plant is a partial failure, owing to the fact that but for six out of the twenty-four hours the plant is used, and for the rest of the time it stands idle. For the running of this plant, in 1912 the taxpayers allowed $35,000,000. From an efficiency standpoint, we are realizing that the school plant is not sufficiently utilized. This condition could not long exist in a private business organization. More return would be required from such large "overhead charges." To circumvent this evil, the after-hour school clubs, athletic clubs, recreation centers,—afternoon and evening,—playground centers, lecture centers, instruction clubs, and other school activities have been instituted. In the desire to bring the schools into closer and fuller contact with the daily needs of pupils and parents, Theodore Roosevelt gave strong impulse to the move to utilize

the public school playgrounds as voting centers on election day. All these social activities are symptoms of a growing consciousness that until now the school and the home have not been sufficiently articulated. The theoretical and the practical have too often traveled separate and parallel paths. Their points of contact have been too infrequent. This plan for teaching fire prevention would help solve one of the problems.

Perhaps this movement once successfully inaugurated, every department of the people's government, such as the tenement department, the public highways department and the police department, might devise ways whereby simple instruction in the duties and obligations of the citizen toward those departments, and the functions and relations of those departments to the citizen, might be explained to the children for the purpose of bringing it directly into the home.

And why not? The Budget of municipal appropriation for 1912 amounted to $182,000,000. The citizen pays the freight. We cannot begin too early to show him and his children how his money is being spent.

Regulating the Height of Buildings.

The presidents of the Boroughs of Manhattan, Brooklyn and the Bronx have been appointed by Mayor Gaynor upon a special committee to consider, among other things, the advisability of limiting to some extent the further construction of skyscrapers in New York. The questions raised, while not new or peculiar to New York, are grave ones, and although it is obvious that the time cannot be long delayed when measures must be taken to regulate the height of buildings, particularly in certain sections of the city, the interests affected are so many and the results of restrictive ordinances would inevitably be so far-reaching that the entire subject presents difficulties that can only be overcome by much study and investigation.

One aspect of the matter concerns what might be termed the public interests, involving consideration of such features as light, air and transportation facilities, which it is apparent cannot be adequately provided under any system of subways, if buildings of unlimited height providing accommodations for thousands under one roof are ultimately erected, without restriction, over the entire area of lower Manhattan Island. Another subject of general and growing interest is that of æsthetics, about which there does not appear to be entire unanimity of opinion but which, nevertheless, should be considered in connection with the heights of buildings, their sites and their arrangement.

Opposed to these interests are those of private individuals and corporations which cannot, in justice, be ignored. Private capital invested in unimproved or poorly improved real estate, under past and present conditions, would scarcely furnish an adequate return if restrictions were placed upon the property limiting the height of possible future buildings.

Certain landlords in New York, however, are themselves beginning to doubt the permanent value of the skyscraper. It is conceivable that something might sometime happen to prejudice tenants against the occupancy of their upper stories. The lower stories of many of them are already undesirable through lack of sufficient light and air.

Robert Grier Cooke, president of the Fifth Avenue Association, who is a vigorous opponent of the erection of loft buildings on the avenue, confesses that he has not met with much, if any, success in his opposition, but when the Asch Building fire happened his association saw its opportunity. It may be pointed out, however, that the Fifth Avenue Association does not oppose high buildings as such, but simply

from a selfish standpoint—that of the inconveniences which the people of Fifth Avenue have to endure if such structures (all of which Mr. Cooke lumps under the one head of "sweatshops") are permitted on that street. The remedy in the eyes of the association was to "bring about proper fire regulations. By so doing," he explains, "we may not only serve a great public purpose through the help that we may give to workers, but also our own purposes of keeping manufacturers of garments—'sweatshops' —off Fifth Avenue."

Following out his plan of making fire regulations the instrument of his purposes Mr. Cooke explains:—

> How will more stringent fire regulations accomplish this? First, because they will require that all new buildings put up shall have broader stairways than is now the case. These stairways will occupy space that otherwise would be rentable, therefore the space left over must command higher rentals. This would render them unsuitable to sweatshop owners. Similarly, by regulations limiting the number of operatives who may work in one room in these new buildings, they would be made less suitable for manufacturers of cheap garments. The restriction of the height of buildings falls right in with the enforcing of new fire regulations. If a builder cannot run up a building to the limit of height, the restricted building must command higher rentals from its tenants and will consequently get a better class of trade—the kind that Fifth Avenue now has and that we want it to have in the future.

Ernest Flagg, architect and building expert of New York City, who at one time opposed the erection of skyscrapers, has been obliged to acquiesce in them as "necessary evils" even in Fifth Avenue. He points out that so far as fire risks go they need not be looked upon as likely to increase those that already exist in that street and those leading off east and west from it. He says:—

> A limitation of height will not remove the fire risk. The only practical way to do that is to build absolutely without the use of inflammable material, and this can better be done in high buildings than in low ones, because as the earning power of high buildings is greater than that of low ones, their builders can better afford to use the more expensive material. The chief danger to American cities from fire lies, not in the high buildings, but in the general flimsy and inflammable character of the low ones. The way to overcome this is to amend the building laws so as to make possible the general use of fire-resisting material, which might easily be done by requiring thicker walls where wooden beams are used and by removing some of the present unnecessary and burdensome restrictions on the use of incombustible material.

It is generally conceded that the abnormal development of the skyscraper in New York City is due to the topographical character of Manhattan Island. The limitations to expansion made by the North and East Rivers have forced land values to such a height that high buildings are imperative if investments in down town Manhattan real estate are to pay. Unfortunately, however, unimaginative Americans have come to think that the skyscraper is the sign of a metropolis, and are rushing into their erection in cities where such absurdities are not necessary. Seattle, for example, is boasting of a forty-two story structure to be completed this

year. "The tallest commercial structure in the world outside of New York City," say the boosters.

Where there is plenty of room for expansion the skyscraper is not only unnecessary, but may prove a positive detriment to a city.

The campaign of the National Fire Protection Association for the limitation of building heights, begun nearly five years ago, is not without favorable result, as is indicated by the list of cities at the conclusion of this article; but the larger cities have been slow to respond, owing to the difficulty of arousing the necessary public interest in the question. A persistent propaganda, however, finally creates enough latent energy to crystallize about some apparently unimportant incident. Philadelphia is an example of this, where in view of the erection of a projected 15-story apartment house on the south side of Rittenhouse Square, heretofore given up exclusively to abodes of moderate height, it is not a matter of surprise that a bill to regulate the height of buildings is being prepared for submission to the State Legislature.

We are indebted to Mr. David Knickerbacker Boyd of that city,—the distinguished architect who as chairman of the Committee on Public Information of the American Institute of Architects has done so much to give the Institute a new and desirable public setting—for a most interesting and instructive commentary on the Philadelphia situation, containing valuable suggestions of his own as to how the matter may be adjusted. Mr. Boyd says:—

The purpose is not to make a plea for the entire abolition of the skyscrapers, but merely for their restriction to such an extent that in locating these tall buildings a perfect economic balance shall be obtained. And when all other considerations have been taken into account the skyline will also have been improved. Instead of the impression now created of the uplifted arms of a crushed and stifled conglomeration of buildings appealing to the heavens for more light and air, we should return to the once simple dignity of the occasional spire or tower arresting the eye of the spectator and pointing his thoughts upward.

It has recently been said that the height of the architectural giraffe is limited only by the capacity of the elevator equipment and the pressure on the earth, but it seems to me that the limit will have been reached long before that, when the pressure upon the public patience has reached the crushing point.

A great hue and cry is always raised by some of the land owners whenever legislation limiting height is proposed, but the supposed right of the few to interfere with the interests of the many cannot much longer prevail, and restriction is bound to follow.

In the movement to correct the evils of the skyscraper much has been said about shutting off the light of the heavens and circumscribing the air of the streets. This "canyonizing" of the streets is rapidly being accomplished, and its baleful results are beginning to forcibly assert themselves. It is known that existing drains and sewers are becoming totally inadequate to care for the additional duties imposed upon them in certain sections by the concentration of humanity in tall buildings. Even the possibility of the disasters that may result from the human congestion of some of the streets—in the case, for instance, of an earthquake tremor, an unusual explosion or the complete suspension of either surface or subway traffic—has been pointed out, but without any suggestion of that adequate remedy—the relieving of the streets themselves.

Our modern civic surgeons have made incisions and provided, through

subways, additional interior means of circulation, and these same engineers have boldly made diagonal surface or skin deep cuts through congested districts, but in spite of these our cities are suffering from anemia. They must be given a freer circulation by widening the streets, and the streets must be given more air and sunlight by keeping down the heights of buildings.

Suggestions have been made for restricting the height and area of buildings, as, for instance, the offsetting or "stepping" of the facades with each increase in height. Such a scheme, while undoubtedly admitting more light and air to the streets below, does not, however, offer any relief to the congestion of the streets, nor does it effectually place a limit on the building height.

The same objection, but in a less degree, would apply to the proposition that, above an established limit of height, a portion of any building may go up in the form of a tower. An absolute limit of height, as has recently been adopted by some of our larger American cities, may be the surest solution of the whole problem, but it is not an ideal one.

The ideal solution will regulate the height of all buildings in a zone or district to the limit best suited to that particular section, and will in turn limit, within such a district itself, the height of each building in proportion to the width of the street or other open space upon which it faces, as was first done in Washington, Boston and most of the European cities.

Needless to say, there would be no lack of light and air around the highest building in the world if it could be erected by itself, or if not planted in too close proximity to another like it; if permanent open spaces surround any one of them there can be no objection to any reasonable height.

Since it seems that we must have some high buildings, we must control them.

Since we should have wider streets, let us, therefore, make the height of the building and the width of the street interdependent, proportioning one to the other in such a manner that as the high buildings go up on the opposite sides of the street they must be made to keep further apart than the low ones.

In order to accomplish this two-fold result, it is my proposition that the owner of any piece of ground who desires to erect thereon a high building shall be compelled to dedicate to the city a portion of that property facing the street for which, of course, the city would have to pay. This means that it is but taken over and paid for by the people who will have to use the street, and who will also occupy the building. Any owner who contemplates erecting on any given street a building which by its very size and nature will attract more people and more business to that particular portion of the street than it can reasonably be expected to accommodate, or worse still, than it actually will accommodate, should be made to furnish a somewhat adequate amount of space, or rendezvous, in front of it. This rule now obtains in several of our large cities.

I would, therefore, limit the initial height—that is to say, the maximum height at the present regularly established building line—to one and one-quarter times the width of the street or open space upon which the building faces. This would give on a street 50 feet wide a 62½-foot high building (if erected at the usual building line), which would be equivalent to a six-story building used for residential or office purposes or a five-story light manufacturing establishment.

Any building taller than this initial height should be so set back that the cornice or top of its perpendicular face shall not extend above an imaginary line which might be called the "building and height line."

Now if this imaginary diagonal be drawn from the curb of any of these streets, assuming the sidewalk to be one-quarter the width of the street, to the top of any building which is the limit of height, above mentioned, at the normal building line and continued into space, it becomes the line of restriction to which I have referred. It is thus apparent that to go up one must go back. This scheme, therefore, forces the entire perpendicular face of the building back from the curb in a fixed proportion to each additional story the building may go up, which can be roughly figured upon as a two-foot increase in the width of the side-

walk for each ten-foot story above the initial height. Thus it also reduces the area of every building in proportion to every story in height, and while it does not absolutely prohibit high buildings, the loss of space entailed by this ever increasing reduction (on a street of average width) will most effectually discourage their erection. To put it in another way, the owner would have to give about two feet of sidewalk to the city for every extra story of its sky he occupied.

As each low building gives way to a higher one, some in five years from now, some in ten, some in thirty, the higher buildings will go back to take their places among their neighbors on the new line of progress, and *ipso facto* we shall have the wider streets where wider streets are needed.

It is obvious also that this process of evolution could be taking place in different parts of the same street at the same time. Thus the least used part of the street under prevailing local conditions might remain comparatively narrow, while another portion would become built up and wider automatically.

This is only beginning to-day to care for the future. And if, for instance, the possibly irregular cornice line or uneven frontal line be deemed objectionable from an aesthetic or administrative standpoint, it need be borne with by one generation only as a concession to the requirements of the next.

Following is a list of the American cities which in the past few years have responded to the agitation for a limitation of their building heights. It will be noted that there is a considerable variation in the character of the restrictions imposed, but that all may be said to have satisfactorily met the situation in one way or another:—

BALTIMORE.—Fireproof buildings limited to 175 feet, and non-fireproof buildings to 85 feet.

BOSTON.—Two and a half times the width of the street; maximum 125 feet.

BUFFALO, N. Y.—No height greater than four times the average of least horizontal dimensions of the building.

CHICAGO.—Until September, 1911, maximum 260 feet; then absolute limit of 200 feet.

CLEVELAND.—Two and a half times the width of street, with maximum of 200 feet. Recesses or set-backs to be counted as added to width of street.

DENVER.—Buildings not to exceed 12 stories. Those more than 125 feet to be fireproof.

INDIANAPOLIS.—No regulations as to height of fireproof buildings, except on Monument Place, which is regulated by State law, where no building shall be over 86 feet.

JERSEY CITY.—No building or structure, except a church spire, shall exceed in height two and one-half times the width of the widest street upon which it stands.

LOS ANGELES.—Limit of 150 feet is fixed by city charter. This applies to Class A steel frame buildings. City ordinance fixes the limit of height at 133 feet for reinforced concrete Class A structures.

NEWARK, N. J.—No building shall exceed 200 feet, but if to be used as warehouses or stores for storage or sale of merchandise, shall not exceed 150 feet.

NEW ORLEANS.—The height at the street line shall not exceed two and a half times the width of the widest street which the building faces, but any portion of the building setting back from the street may be increased in height up to two and a half times the distance from the face of such offset to the property line at the opposite side of the nearest street.

PATERSON, N. J.—Warehouses and stores must not exceed 100 feet in height.

PORTLAND, ORE.—Code of 1911: "No building or other structure hereafter erected, except church spire, shot tower, water tower or smokestack, shall be of a height exceeding 160 feet."

SCRANTON, Pa.—All buildings limited to 125 feet.

ST. LOUIS.—On streets less than 60 feet, two and a half times the width—maximum 150 feet—except hotels, which are limited arbitrarily to 206 feet. Office buildings may be erected to a height of 250 feet, under special conditions.

ST. PAUL, Minn.—Not more than 20 stories; 250 feet maximum limit.

TACOMA, Wash.—Class A buildings shall not exceed 12 stories or 152 feet. If all interior as well as exterior is of fireproof construction, same can be 16 stories, or 200 feet.

WASHINGTON, D. C.—In the main the limit is the width of the street plus 20 feet; maximum 130 feet on business streets (160 feet on north side of Pennsylvania Avenue), and 85 feet on residence streets.

Roofing Materials—Their Comparative Cost.

The rapid awakening of the public to the conflagration hazard involved in the use of wooden shingles as a roofing material has precipitated a general inquiry into substitutes for the time honored—or dishonored—wooden shingle. Tile and slate have of course been used for many years and not only their fireproof qualities but their wearing and weathering qualities have long been recognized. Because of the weight of these materials, however, they cannot very well be substituted for shingles on the roof originally constructed to carry a covering of lighter weight. The object of present public inquiry is therefore to find a satisfactory covering, not too heavy, for two by four or two by six-inch roof joists.

A special inquiry has been made by the QUARTERLY into the comparative first costs of roof coverings now upon the market. The service record of several of the same is not obtainable and their wearing and weathering qualities cannot therefore be given. Most of the prepared roofings require annual painting or dressing for their proper care, as do also metal and tin roofs.

The following prices include the cost of material and the cost of laying the material on the roofs, together with the necessary nails, fastenings, copper flashings (in the case of slate and tile) the usual roofing paper that is applied under shingles, and the heavier felt that is put on the roof under slate and tile. The square, or one hundred square feet, is the usual unit used for quotations in figuring work.

At the present time shingles of average grade cost from nine to ten dollars per square, and there is every prospect that the price of the same will continue to gradually advance. Shingles weigh from 200 to 300 pounds per square and increase considerably in weight when wet.

There is a great variety of prepared "ready" roofings on the market which are sold in rolls and can be applied to roofs at a minimum of expense. The average price of these materials is six to eight dollars per square, but the cost of each varies according to the thickness or ply of the

material. The heaviest of this type of roofing will weigh considerably less than 100 pounds per square.

Flexible asphalt shingles are now made of wool felt saturated with asphalt and surfaced with crushed slate or granite. Such shingles appear to possess strong fire-resisting qualities. They cost on an average of eight to ten dollars per square and weigh not over 250 pounds per square.

Asbestos shingles vary in price according to color, shape and weight. A gray shingle of the weight most generally used will cost from ten to sixteen dollars if cut after the French style or diagonal in shape. If these gray shingles are cut after the American style, or oblong in shape, they will cost from thirteen dollars and fifty cents to seventeen dollars and fifty cents per square. This higher cost is explained by the fact that shingles laid according to the American custom will overlap more than do those of diamond shape laid diagonally according to the French custom. Either class of shingles, if colored, will average about three dollars more per square. These shingles will weigh 300 pounds per square in diagonal, or 450 pounds per square laid according to the American custom.

Corrugated iron will average about seven dollars and fifty cents per square, and tin will average about twelve dollars per square.

All of the foregoing materials may be applied to average dwelling houses having roof joists of 2x4 or 2x6 spaced sixteen inches apart. The following classes of roofing material, however, necessitate heavier roofing timbers, 2x8 joists being generally recommended. This is said to add very little to the cost however.

There is a form of asbestos protected metal that has found favor with many people. This is furnished in the form of flat or corrugated sheets in various weights and will cost from about eleven to fourteen dollars per square according to weights, and will weigh from 550 to 650 pounds per square.

Slate will cost from ten to fourteen dollars per square according to grade. In general, cheap slate can be laid on the roof in most localities at the same cost as shingles. The use of only the better grades of this material is advisable, however. In the vicinity of slate quarries this form of roofing may not cost over seven dollars per square. Slate weighs from 650 to 700 pounds per square.

One of the most attractive and unquestionably the longest-lived form of roofing material is tile, although the first cost is relatively large. An average good class of tile will cost twenty-five dollars per square and weigh 800 pounds per square. Other classes of tile may weigh 1200 and even 1800 pounds per square, and the price is equally high. However, very attractive tiles may be procured at twenty-five dollars per square and this would add little comparatively to the cost of a good brick or concrete house, and the expense of maintenance would be practically eliminated.

Waterworks Systems and the Fire Protection Problem.*

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In any waterworks system the requirements imposed by the fire protection problem have very much in common with those involved in furnishing an adequate and reliable domestic supply.

The success of any enterprise is dependent upon its financial resources and the organization of its working force. Under ordinary conditions a per capita expense of from thirty dollars to forty dollars is necessary to develop an adequate waterworks system. Climatic and topographic conditions, however, are the controlling factors, and in localities where expensive water rights have to be acquired, or where a wide range in elevation exists, the expense may increase to about double the above-named figures.

One of the fundamental difficulties encountered in properly developing a waterworks system is the securing of necessary funds to develop the works in advance of the increase in consumption. In some cases this difficulty is due to lack of confidence in the engineering ability of the department, and in others to political reasons. No money is ever saved by postponing a proper development, for in nearly every case the delay causes a large loss by necessitating a temporary construction which is comparatively useless in the regular development of the works, besides subjecting the inhabitants to extreme inconvenience, and perhaps exposing the city to epidemic and conflagration.

Instances of dilatory tactics in financing necessary developments are, unfortunately, too numerous; in fact, a large proportion of our cities outgrow their supplies or equipment before the necessary additions are made. For example, the city of Lawrence, Mass., was warned early in 1900 that the consumption had reached the winter capacity of the filter beds, which at that time were not covered. Yet no money was placed at the disposal of the water board until 1906, when a new covered filter was contracted for, but not in time for construction work to be completed before the cold weather set in. The supply available from the old filter was so seriously depleted during the exceptionally cold weather of December of that year and the following month that early in February not more than one million gallons of water was available in the reservoir. At this time relief was

* Read at a meeting of the New England Waterworks Association.

afforded by water supplied from the mains of adjoining towns. If a large fire had occurred during the period of low water in the reservoir, it would have been necessary to take suction from the river, which is highly polluted with sewage, in which case an epidemic of typhoid fever would have been inevitable.

As a second example, the city of Worcester, Mass., may be cited. In 1902 the necessity of starting the development of the Asnebumskit supply was apparent to those who were acquainted with the needs of the city, and though engineers worked very strenuously each year during the intervening period to secure the necessary funds to prosecute this work, no considerable money was provided until 1911.

In order to enable the employees, when well organized, to render prompt and adequate service, complete records, properly filed, and suitable quarters are necessary. The most essential records are as follows:—

A skeleton map of the distribution system on a scale of about 1 in. to 500 ft., showing mains, gates, and hydrants, is of great use for reference purposes, and of particular value in making studies for the extension or reinforcement of the distribution system.

Detailed locations in platform on a scale of about 1 in. to 40 ft., showing mains, gates, and hydrants, are indispensable, and it is convenient in many cases to show service connections on these sheets as well.

Records of service connections, gates, hydrants, and meter locations should be arranged in card index form.

The location of gates on the distribution system and those on services larger than two inches in diameter should be arranged in convenient form for ready reference, and copies of these records should be supplied to all employees authorized to operate gates.

Records of pumpage or delivery of flow lines, as made by one of the several accurate continuous-recording devices now on the market, should be kept, and the pumping station records should show the complete performance of the equipment.

Records of pressure maintained at several points of the system should be secured by the installation of recording pressure gauges.

The above-mentioned records, together with such necessary and desirable amplifications as may be called for, should be kept up-to-date. The more important plans and records should be in duplicate, and one set should be stored in a substantial fireproof vault. The question of guarding records against destruction by fire cannot be too strongly emphasized, and it is to be regretted that it is a subject which is often completely or partially neglected. The ordinary fireproof vault is of questionable efficiency in a conflagration, and in many cities it is the custom to provide safe storage at the supply works, but removed from the danger of sweeping fires.

The engineering office, which generally occupies a building in common with the executive and clerical forces, should have ample area for carrying on the maximum amount of work which is liable to devolve upon this branch of the service during periods of active construction. The room or rooms should be properly ventilated and supplied with both natural and artificial light. Partitions should be so constructed that the occupants shall not be subject to the intrusion of the public, or other distraction. Well-arranged filing cases and vaults should be readily available for the storing of all plans and records. A library should be provided which should contain the latest

editions of the most desirable handbooks and scientific works bearing on the various subjects which have to be dealt with in the design, construction, and operation of a waterworks system, and in addition a file of the best engineering magazines should be available, so that the working force may keep in touch with work of a nature similar to their own carried on in other cities.

The storage yard, usually containing a repair shop and stable, should be of ample area, and so located that shipments of material may be conveniently and economically handled both from the cars and in the area covered by the distribution system. The yard should be so laid out with paved drives that all the stock shall be readily accessible, and chain falls, with either derricks or cranes, should be provided for handling the heavier pieces. Fittings, valves, and hydrants may well be kept in covered sheds. If the yard is located in a closely built-up district, it is particularly desirable that the buildings be of fireproof construction; otherwise, they should be equipped with sprinklers, standpipes, and hose. The shop should contain tools of the kinds and sizes required to do all but the heavier repair work, and particular attention should be paid to the lay-out of the meter repairing and testing rooms. The offices of the several branches of the work should be connected by telephone, and constant watch should be maintained at the repair shop in all cities having a population of over fifty thousand. The requirements mentioned thus far are necessary for the construction and maintenance of a waterworks plant furnishing a reliable domestic supply.

Fire alarms should be received over the gong or tapper circuit of the fire-alarm system in one or more offices of the department, and at least one employee familiar with the distribution system and prepared to operate gates should respond to all first alarms in mercantile and manufacturing districts, and second alarms elsewhere. Provision in duplicate should be made for notifying the pumping station of alarms.

The experience of many departments, as well as of public service corporations engaged in similar work, is that the motor-driven vehicle has become a necessary adjunct to the equipment of every waterworks system. It enables a prompt response in case of accident, and increases the efficiency not only of the executive force, but also of the laborers in many branches of the work. There is hardly a plant of any magnitude on which one or more automobiles cannot be profitably operated.

The source of supply must be carefully studied before its adequacy from the fire protection standpoint can be determined with certainty. The total quantity of water used for the extinguishment of fires is proportionately very small, being approximately one tenth of a gallon per capita per day, or in round numbers about one thousandth of the total consumption, but for short periods of time the rate is very high. From a perusal of the consumption records of any well-operated works, the maximum hourly, daily, and monthly rates can be readily determined, and from a study of the structural conditions in the city—areas, heights, protected openings, exposures, occupancies, construction of buildings, etc.—the probable maximum quantity which would be required to combat a fire of large proportions can be estimated within reasonable limits. The number of fire streams required simul-

taneously in cities of average character has been discussed by our leading hydraulic engineers, with practical unanimity of opinion. Their estimates are based on actual practice, and the values given by Mr. Kuichling are expressed by the formula $Y = 2.8\ V x$, where Y equals the number of 250 gallon streams and x equals the population in thousands. This formula does not make any allowance for broken services, and should be applied only after a study of the local conditions has been made, for in many cities the size of the mercantile or manufacturing districts is not in proportion to the population. Although the chance of a large fire occurring during the hours of maximum consumption is somewhat improbable, nevertheless it is wise to err on the safe side, and to use the maximum hourly consumption figure in the calculations, although in most cases the maximum daily rate may be used with comparative safety. This step is not so unreasonable as at first appears, for any city should have its supply developed somewhat in advance of present requirements, in order to care for future growth. In cities not exceeding one hundred thousand in population, where the lawn-sprinkling is restricted to certain periods of the day, it is feasible to enforce an ordinance prohibiting irrigation during the progress of a fire, thus materially reducing the maximum rate for which the city would otherwise have to provide. In some cities, dependent upon fire engines, the pressure is so reduced by large fire draughts that the domestic consumption rate will drop appreciably. Such distribution systems cannot, however, be considered adequate for the service required of them.

There are many cities located on large lakes and rivers where a practically unlimited supply is available, and one does not have to give the question a thought, but in others it is a most important question with the engineer. In these latter the problem is varied, but resolves itself into some method of storage so that the maximum rates can be delivered to the distribution system. If the supply is derived from driven wells, they should be so developed as to furnish the maximum daily rate, and the maximum hourly and fire-flow rates may economically be cared for by storage in a covered reservoir available for delivering into the distribution system. If the supply is derived from storage from a large catchment area, the capacity of this storage should be ample to meet the demands made upon it through a series of dry years. In dealing with such a supply, the average daily consumption, and not the varying hourly rates, must be considered in determining the minimum capacity of the storage reservoirs.

The source of supply having been determined, the method of delivery to the distribution system confronts us. In many cases where the supply is derived from rivers and lakes, and generally when delivered from storage reservoirs, these sources are at an elevation sufficient to deliver the supply by gravity. In a few cases the topography of the country is such that the sources of supply are in close proximity to the distribution system, but in by far the greater number they are at some distance. In the latter cases, distributing reservoirs within or near the area served by the distribution system become an economical necessity, for their existence permits the use of much smaller conduit lines. These lines should have a capacity at least equal to

the maximum daily consumption, and one such line cannot be depended upon unless the storage in the distributing reservoir is ample to furnish the supply during the longest period that will be required to make repairs. The conduits delivering the Catskill supply to the city of New York, the Owens River supply to Los Angeles, and the Wachusett supply to the Metropolitan District of Boston, are not in duplicate, but the permanency of their construction and the storage provided along their routes and at their termini assures the continuity of the supply. On systems where there is more than one supply line, these lines should not follow the same route, as the failure of one may cause the failure of another, or both may be put out of service at the same time from the same cause, as was recently the case in Seattle, Wash. Where pumps are required to deliver the supply to the distribution system, the pumping station should be of fireproof construction. No valid excuse can be offered for not constructing stations absolutely fireproof. The installation of sprinkler equipment, standpipes equipped with hose, and chemical extinguishers, in the many existing stations which are not fireproof, should be strongly advocated. In all cases oil should be stored outside the building, and all internal hazards should be reduced to a minimum. When stations are exposed to external hazards, outside sprinklers, water curtains, and wire-glass windows should be provided. On buildings having incombustible roof coverings and cornices these give reasonable protection.

The selection of the equipment of the station requires careful study, in order that units of proper capacity and number to insure economic and continuous service may be provided. Plants which are supplied by pumpage may be broadly divided into three classes; namely, those which distribute from a storage reservoir, from an equalizing reservoir, and direct from a station. Under the latter class those which are supplied with an equalizing standpipe should be included, for in only small towns can a standpipe furnish any reasonable proportion of the draught, and in the larger cities it is a useless adjunct, as the pressure can be as uniformly maintained by means of pressure governors.

The stations which deliver direct to the system will first be considered. Their pumping capacity should be sufficient to deliver the maximum domestic and fire draught combined, with any two units in reserve; and the boiler capacity should be sufficient to enable the pumping of this maximum draught by the most uneconomical units in the station, with one boiler out of service for repairs or cleaning. This requirement of two reserve pumps over and above the maximum capacity has frequently been questioned, one of the foremost objections offered being the large amount invested for machinery which may never be called into use. The answer to this objection will be given along the line of cost. If the city were located in close proximity to a hill of sufficient elevation to furnish the desired pressure, the advisability of building a reservoir of sufficient capacity to assure the supply would not be questioned. Such a reservoir would cost, in round numbers, about $5,000 per million gallons, which corresponds closely with the cost of high-duty pumping machinery of equal capacity; and low-duty or centri-

fugal pumps can be purchased at a much lower figure. Viewed from the cost standpoint, therefore, no argument can be adduced against installing pumps to perform the same function as the reservoir.

Where an equalizing reservoir is in service, the pumping capacity need not be as great as in the preceding case, but there should be one unit in reserve over and above the maximum possible draught for ten hours, minus the reservoir capacity. When a station delivers to a storage reservoir, the pumping capacity should be equal to the average daily draught during the maximum month. Such capacities may perhaps appear high to many who have successfully maintained an ample supply from stations which are not equipped with the above-mentioned reserve units, but no station can be considered reliable unless it can maintain the supply at all times, and it is not infrequent in a station containing four or five units for two to be out of service at the same time, and, although one of the units may be undergoing only trivial repairs, such as replacing valves or packing glands, it would nevertheless be impossible to get it back in service on short notice.

The capacity for coal storage should be sufficient to hold fuel enough to run the plant through any period in which the delivery may be interrupted by strikes or unfavorable weather conditions, and coal to meet such emergencies should, of course, be kept always on hand.

If the water is delivered direct from the pumping station to the distribution system or to an equalizing reservoir, there should be two or more discharge mains, and their capacity should be such that with any one main out of service, the other or others could deliver somewhat in excess of the maximum domestic consumption; and, of course, it would be much more desirable if, under such circumstances, the maximum domestic and fire draught combined could be provided for. When delivering into a storage reservoir one main having a capacity equal to the maximum daily rate is ample, for repairs can be made before the water in the storage reservoir will be exhausted.

To-day filtration plants are in operation in many cities, and the capacity of these plants need not be so great as the maximum hourly rate of consumption if enough filtered water is held in storage at some point on the works, to provide for the draughts. On many plants this supply is provided by large covered clear-water basins which supply the high-lift pumps. In some plants a by-pass is installed so that unfiltered water can be delivered direct into the distribution system in case the fire draught exceeds the capacity of the filters and exhausts the supply in the clear-water basins. Where the original source is contaminated, however, this expedient should not be resorted to, but provision should rather be made for additional clear-water storage, as an epidemic is even more undesirable than a conflagration.

The supply mains connecting the storage or equalizing reservoir with the distribution system should be by-passed around the reservoir, and of such capacity that the maximum rate can be delivered with any one main out of service. In some cases, the installation of cross-connections and suitably located gates in the supply mains enables their size to be somewhat reduced. Blow-offs should be established at all low points, for it often requires more

time to empty a main and dispose of the water than it does to accomplish the actual repair work.

In the construction of force and supply mains, the question of material is often difficult to settle. Cast iron, wrought iron, steel and wood are each used with good results. Up to thirty inches in diameter, cast iron generally proves the most economical, but in larger sizes steel lines prove cheaper even if they have to be replaced within twenty-five or thirty years. Besides, it is impracticable to use cast iron in mains of more than sixty inches in diameter. The carrying capacity of lines constructed of either material gradually decreases, but the cast-iron lines can be cleaned and their capacity restored at a nominal cost. On the other hand, cast iron is subject to rupture, which will put the line completely out of service, while in the case of steel, any general weakening of the structure is portended by small leaks. Continuous wood stave pipe has proved very reliable; it is almost always cheaper, can be readily repaired, and maintains its carrying capacity throughout its life.

All force and supply mains should be equipped with air valves at their high points and they should be frequently inspected, for a defective air valve will cause a steel or wood line to collapse in case of a break at one of the low points.

There is no better item to observe than the per capita consumption records if one cares to make a snap judgment in regard to the efficiency of the operation of a waterworks system, for almost invariably the high consumption rate is a sign of inefficiency, and, conversely, the low consumption rate is indicative of efficiency. The per capita rate which is necessary to meet modern conditions in our cities ranges from about 50 to 150 gallons per day, but these rates are exceeded in most of them. This unnecessary consumption has a very important bearing upon the question of cost, for it has to be met by the development of larger supplies, the construction of addition filtration works (if there are any), and the installation of additional pumping equipment and of force, supply, and distributing mains of increased carrying capacity, if the domestic and fire-flow requirements are to be fully met. Unfortunately, in such instances the fire-flow is generally only partially provided for during periods of maximum domestic consumption.

The installation of meters is the surest and practically the only way to effect a permanent reduction of the per capita rate. Many and fallacious as are the arguments advanced by the opponents of the general installation of meters, the results where they have been installed are incontrovertible. Waterworks engineers are not as yet agreed that the metering of all services is an economic necessity, but the results attained in cities that have metered practically every service show that as much benefit may be derived from metering the last ten per cent of services as was obtained from any prior installation of an equal number of the same size. The water used in public buildings and for other municipal purposes is generally far in excess of that actually needed. In cities which have paid particular attention to this class of consumption, the conclusion reached is that all water used by the several city departments, except for the extinguishment of fires, should be metered

and paid for by the users. Such a course not only effects an important reduction in consumption but gives the water department credit for the service rendered.

One of the points upon which insurance and water engineers differ is in regard to the metering of fire services. The waterworks engineer, who generally takes the affirmative side of the question, is in much closer touch with the situation, and when such results as the following are obtained, there seems to be no doubt in regard to the justification of his stand.

Worcester, Mass., metered all fire services in 1905, and the following year the revenue increased $15,000, and the consumption decreased over 300,000,000 gallons.

Lockwood, N. Y., metered all fire services, and the following year the revenue increased twenty-five per cent and the pumpage decreased twenty per cent.

The pressures which are maintained on works which are supplied by gravity from distributing or equalizing reservoirs are governed by the elevation of the reservoirs. In many cases suitable sites are not available at desired elevations, but when they are, it is highly desirable to so locate the reservoir that a pressure of one hundred pounds will be maintained over the greater portion of the distribution system, and particularly in the closely built-up sections. In a recent paper, Mr. E. V. French dwelt upon the advisability of such a pressure, and showed that it was sufficient to furnish direct hydrant hose streams to all fires except those in the larger and higher buildings, for which more powerful streams would have to be furnished by fire engines. As the number of fire engines can be greatly reduced if many streams can be taken direct from the hydrants, a very considerable saving can be thus effected, for it costs between three and four thousand dollars a year more to maintain an engine company (horse drawn) than to maintain a hose company. In planning for extensive improvements in any city, therefore, it is desirable to provide, if possible, for the raising of the pressure to about one hundred pounds, for in addition to cutting down the expense of the fire department, other economies can in this way be also effected. Take, for example, the large cities of New York, Chicago, Philadelphia, and Buffalo: in these it is necessary to pump all the water used in buildings of moderate height and in small plants, and this could be done more economically in one central station. Of course it would still be necessary to pump the supply to buildings over 200 feet in height, but these are comparatively few.

Next in importance to the saving which could be accomplished is the increased reliability of sprinkler equipments when supplied from a central station. The number of such equipments in service is increasing rapidly, and they constitute practically the only safeguard to buildings of non-fireproof construction and fireproof buildings containing combustible material. In many systems supplied by direct pumpage, provision is made to raise the pressure upon receipt of fire alarms and maintain this pressure until the "all-out" is sounded. This practice is good, and may well be adopted in all such systems. The permanent raising of pressure on a sys-

tem does not necessarily increase the consumption, for thorough inspection and the prompt following up of defects will enable an unincreased consumption rate to be maintained. This has been proven in several cities during the past few years, and though heavier materials, requiring more careful workmanship, are used in the original installation, the subsequent cost of maintenance of a distribution system under 100 pounds pressure is no greater than under 50 pounds pressure.

Few engineers have the opportunity to design a new distribution system for a city of any considerable size. New Orleans is the only large city which has installed a new piping system in the last score of years. The problem of to-day is the reinforcement and rehabilitation of outgrown distribution systems, or of systems which have deteriorated in carrying capacity or were faulty in their original design. To accomplish this task, a careful study of the existing system should be made, present requirements determined and proper allowance made for future growth. This done, a plan for all future work should be adopted and followed. This plan should include main arteries of ample carrying capacity girdling the city as its growth demands, secondary feeders of suitable size about 3,000 feet apart in either direction, and dead-end lines extended to outlying sections without reduction in size—the system to be so designed as to furnish fire protection as follows:—

(*a*) In outlying residential districts not likely to become closely built up, a minimum of 1,500 gallons per minute.

(*b*) In closely built up residential and minor mercantile sections, 2,000 to 5,000 gallons per minute.

(*c*) In manufacturing, warehouse and congested value districts, from 5,000 to 20,000 gallons per minute, depending on the structural conditions.

The above supply should be in excess of the maximum daily domestic consumption, and should be available in manufacturing districts to any large group of buildings of special hazard, and in mercantile and residential districts about any block. In order that these quantities shall be available, the following minimum sizes of mains should be used for hydrant supply:—

For residential districts, six-inch and eight-inch mains, the former to be used only where they complete a good gridiron, and the latter in locations where dead-ends and a poor gridiron are likely to exist for some time, and in all blocks 600 feet or more in length.

For mercantile and manufacturing districts, eight-inch and twelve-inch mains, the former to be used only in sections where they complete a good gridiron, and the latter for long lines not cross-connected.

Four-inch mains cannot furnish sufficient hydrant supply, and should be replaced as fast as circumstances will permit, the replacement to commence in the more thickly built up sections. In order that not more than one hydrant will be on a six-inch, nor more than two hydrants on an eight-inch main between intersecting lines, dead-ends should be eliminated wherever practicable, large mains cross-connected to distributors at all intersections, and long unsupported lines of pipe cross-connected.

The city of Reading, Pa., affords a good example of the results which may be accomplished by the adoption of a well-designed plan to be followed out in future construction. Some seventeen years ago such a plan, prepared by the superintendent, Mr. E. L. Nuebling, was approved by the city, and has been followed since that time. At present, there are ample quantities of water available for both domestic and fire protection purposes throughout the entire system, and future additions to meet increased growth in population can be readily and economically made.

Unfortunately, the topography of some cities precludes the making of plans for future growth, for it is impossible to foresee in what direction that growth will extend. For a number of years the probable growth of Los Angeles appeared to be in an easterly direction, and it is only in the past two or three years that a definite trend showed it to be in a westerly and southerly direction.

Tar-coated, cast-iron pipe is unquestionably the best material to install in a distribution system. In some parts of the country kalameined pipe is extensively used, because of the saving in freight rates which can be effected on account of its lighter weight, and this pipe gives very good results. Machine-banded wooden pipe does not give satisfaction in a distribution system on account of the excessive leakage which generally occurs. Cast-iron pipe should be inspected at the foundry and again before it is lowered into the ditch. Special care should be taken to prevent any foreign matter from getting into the line during laying, and the line should be thoroughly blown out before it is put into service. If practicable, a test pressure of one and a half times the working pressure should be applied to the line before backfilling.

Pipe less than six-inch in diameter should never be installed to furnish hydrant supply. In cities where the distribution system is weak, it is desirable not to install any pipe less than eight inches in diameter, for the new lines of these larger sizes will reinforce the old lines. The weight of pipe purchased should be sufficient to enable at least 300 feet head to be maintained at the point of lowest elevation in the city. If the heavier classes of pipe are installed, it enables the pressure on the system to be raised to the desired point without the additional expense which would otherwise be required for relaying. The coefficient of carrying capacity of the older lines should be determined by experiment, and in many cases, where the supply is deficient, the results obtained will show that it is more desirable to clean the line than to lay a new line. Sufficient cover should be provided to insure the pipe from freezing, even in the coldest winter. Exposed pipes at bridge crossings should be well supported and protected from injury, and extreme care should be paid to the design of the line near the approaches.

Electrolysis is a subject which must not be neglected, for it is most insidious in its action. Frequent surveys should be made, and remedial measures approved by the best waterworks practice, rather than those generally advocated by street railroad engineers, should be adopted. Grounds from electric circuits should be made on the street side of the

meters, main cocks, etc., in accordance with the National Electrical Code, and no power circuit which depends upon a grounded return should be connected to the system in any manner.

In order to operate a distribution system with the desired facility, the mains should be equipped with gate valves so located that no single case of accident, breakage or repairs to the pipe system in important mercantile and manufacturing districts will necessitate the shutting from service a length of main greater than the side of a single block, or a maximum of 500 feet, or in other districts a length greater than two sides of a single block, or a maximum of 800 feet. If possible, the location of gates should be uniform; that is, they should be set on the property or curb lines at street intersections, so as to be more readily located. On paved streets it is advisable to provide a box or vault of sufficient size to permit of packing the gland without excavation. When the approximate location of a box is known, and it is covered by dirt on an unpaved street, or by ice, a pocket compass will prove an invaluable aid in determining its exact location, for by passing the compass over the supposed location, about an inch above the ground, the needle will deflect toward the iron cover, and by a little careful work can be made to indicate the exact center of the cover. The compass will determine the location of a box that is covered as deep as one foot. This method is also of use in finding cast-iron service boxes which have been covered by granolithic sidewalks.

The gate valves on a system should be inspected at least once a year, at which time they should be operated, and packed if necessary. The boxes should be kept clean, and if water is liable to collect and freeze in them, they should be provided with a drain to the sewer or be pumped out. All operating nuts should be of the same size, and all gates should operate in a uniform direction. On a system of any considerable size, gates should only be operated by employees specially assigned to the work, and a record should be kept by them of each operation. Careless inspection and operation is sure to cut down the carrying capacity of the system by allowing some gates to remain closed, and frequently causes serious delays in cases of accident. Occasionally division gates between different services are left open, and the apparent increase in consumption in the higher service is puzzling to the superintendent until the cause is discovered. In one city where a record of gate operation was not kept and inspections were infrequent, an examination of 7,000 valves showed:—

49 closed and 300 partially closed valves on lines from 4 to 20 inches in diameter.
12 inoperative valves.
100 valves either not on the plans or not in the ground.
2 gate vaults completely filled with crushed stone.
1 division gate open.
1,952 boxes requiring cleaning.

In a smaller city an inspection of forty valves showed:—

1 valve closed.
1 valve with a broken spindle.
1 valve so deep that it could not be reached with the wrench.

2 valves operated in a direction opposite from the others, and no note made of the fact on the plans.
2 valves inaccurately located on the map.
3 valve boxes filled with bricks and earth.
1 operating nut too large for the wrench.

The hydrant is the last link in the chain from the source of supply to the point of delivery to the fire hose lines. Hydrants should have six-inch barrels with six-inch gated connections to the main and a foot valve having a free waterway of at least twenty square inches, so that the loss when 1,000 gallons are being withdrawn shall not be excessive. In cases where provision is made for more than one engine to take suction from a single hydrant, the above dimensions should be increased, and no loss greater than four pounds should be permitted when hydrant hose streams are utilized. The operating nuts of all hydrants in a system should be of uniform size, and turn in the same direction. Where hydrants are supplied from different services it is advisable to paint those on separate services a distinctive color. Care should be taken to have the threads on the outlet nipples of the same size as that adopted by the fire department for hose couplings, and it is especially desirable to adopt the National Standard hose thread, so that apparatus summoned from neighboring cities can make connections.

Hydrants should be frequently inspected to assure their operation. They should be packed and lubricated, and the outlet caps greased, at least once a year, and they should then also be operated and blown out. Before cold weather sets in they should be carefully inspected for drainage, and if any are set below the ground-water level the drips on such should be plugged and the water in the barrel pumped out. During periods of cold weather those in high-value districts should be inspected once a day, and those in other sections twice a week. Special connections should be provided for filling flush wagons and sprinkling carts, and the use of fire hydrants should be confined solely to the fire department.

The question of the distribution of hydrants in a city is a very important one from the fire department standpoint, on account of the great friction loss in long lines of hose. The distribution should be such that ample quantities of water can be delivered to a large fire from hydrants at an average distance therefrom of not more than 350 feet. The customary method of figuring hydrant spacing on a linear basis does not convey any definite information, for, without a knowledge of the size of the blocks, linear spacing would be apt to convey an erroneous impression. For example, the locating of hydrants at linear distances of 200 feet in one city where the blocks are 200 feet square would, in the matter of distribution, be equivalent to the locating of hydrants at linear distances of one hundred feet in another city where the blocks are 800 feet square—in either case the area served by a single hydrant being 40,000 square feet. Under the differing block conditions referred to, Portland, Ore., illustrative of the former, would require one hydrant at each street intersection, or one hydrant to a block; while Salt Lake City, illustrative of the latter, would require sixteen hydrants to each block between the center lines of the four

bounding streets. It is clear, therefore, that the area in square feet served by each hydrant is the proper unit to adopt in order to be able to determine the adequacy of hydrant distribution and to make comparisons. Where it is necessary to concentrate 10,000 or more gallons of water per minute upon any building or block, there should be one hydrant for each 40,000 square feet. In minor mercantile and small manufacturing districts and in densely built-up frame areas, there should be one hydrant for every 60,000 square feet, and as the buildings become less congested the distribution may become wider, up to 120,000 square feet in outlying residential sections.

From the operating standpoint the inside independently-gated hose outlet cannot be considered as giving the best results. The leverage furnished by the wrench ordinarily used by the fireman is far in excess of that required to operate a valve of equal size in any other service, and so great that the stem can be broken or other parts crushed without any undue exertion on the part of the operator. The end to be attained may best be accomplished by attaching outside hose gates before the hydrant is open, and such a procedure will not introduce an objectionable delay. Such gates carried on hose wagons are more reliable, as they can be easily inspected and kept in working order.

The matter of original expense is also a very important item. Assume a city with 2,000 hydrants and sixteen hose or engine companies. To equip the two and one-half inch outlets on all the hydrants would cost over $20,000, while to supply the sixteen companies each with four hose outlet valves would cost about $650, and the cost of maintenance would be in about the same proportion. It is not so practicable to deal with the four and one-half inch steamer outlets in the same way, because the portable valve is much heavier, so where it is desirable to connect a steamer to a hydrant which may already be delivering to a hose line, or where there are two steamer connections on a hydrant, it proves more convenient to equip these outlets with inside gates.

The purchaser of a hydrant should insist upon having the waterways carefully designed, the castings smooth, and the workmanship good. The neglect of these points often admits of the installation of a type of hydrant which is well-nigh valueless. There are hydrants in service in some cities to-day which show a loss of thirty-five pounds between the street main and the hose outlet when 600 gallons of water are being drawn, whereas there are many hydrants of reliable make and at reasonable cost which can deliver the same quantity of water with a loss of less than four pounds.

The requirements necessitated by the fire protection problem are, of course, a large factor in the cost of a waterworks system, increasing that cost from fifty to one hundred per cent over what it would be were the question one solely of furnishing water for domestic and business purposes. But these requirements have to be met, and while in no one city are they all fully provided for, a large number of our municipalities are earnestly endeavoring to attain the best possible results in this connection, and it is to be hoped that their example will be speedily followed by those that now lag behind in the matter of waterworks administration.

It is evident from the foregoing that the fire protection problem is one of the first importance for the waterworks engineer, for it is primarily with him and the fire department that its solution lies. It is perhaps not to be expected that any waterworks system will fully meet its requirements in all their complexity of detail, but while the ideal is never attainable, it is always more and more nearly approachable. That it may be the more nearly approximated to in the design, construction and maintenance of a waterworks system, our municipalities should make it an indispensable part of their policy to secure for this work the best engineering talent available, and then leave it unhampered by political or other considerations to pursue its course toward the realization of what men are striving for and municipalities hoping for,—the watchword of the century,—a maximum of efficiency at a minimum of cost.

Direct Connections from City Water Mains to Sprinkler Systems and Standpipes.

By F. A. Raymond (Member N. F. P. A).

The subject of this paper is one concerning which there has been much discussion in the past few years, both as to the advisability of making such connections and as to the necessity of limiting the sizes of the connections or otherwise restricting them. This paper is an effort to throw some light on both the subjects and to give the opinion and practice of leading authorities. Some have thought that no restrictions should be placed by the city authorities on the size and number of connections, that they should be limited only by the size of the street mains and the desires of the building owners, while others have gone so far in the other direction as to contest any large connections whatever. It is evident there should be a happy medium, connections which will be small enough for safety and yet large enough for efficiency.

Perhaps this discussion should have commenced like a certain famous recipe for cooking a rabbit—"First catch your rabbit." So I might say, "First catch your sprinkler system." In this connection a glance at the experience of the Associated Mutual Fire Insurance Companies will be of value, as they have had more experience with automatic sprinklers than any other organization. These companies are purely mutual, and their efforts are directed toward the prevention of fires and the development of appliances designed to reduce the fire loss.

In the 60's and early 70's the automatic sprinkler had not been invented, but mill buildings were quite generally equipped with standpipes and perforated pipe sprinklers, normally empty, with outside gates to be opened in case of fire. In those days the cost of mutual insurance,

which is the actual loss plus a small amount for inspection work, etc., was about 32 cents per $100 of value insured. In the decade 1900 to 1910, with nearly all Mutual mills sprinklered, the cost was 6½ cents per $100 of value, or in other words the fire loss had been reduced 80 per cent. The Mutual companies are unanimous in ascribing by far the larger part of this saving to the automatic sprinkler. In the 80's there were still some doubts as to the efficiency of sprinklers, so a table was compiled of fires in mills, between 1877 and 1887, with this result: at 759 fires in unsprinklered mills, the average loss per fire was $7,500; at 206 fires in sprinklered buildings, the average loss per fire (including the water damage of course) was $1,080, or only one seventh as great as in the unsprinklered mills. This was in large buildings, mainly with highly inflammable stocks, and is a most remarkable showing, for at that time the automatic sprinkler was far from its present perfected state. Although automatic sprinklers have been in use now for many years and have proven their efficiency and value over and over again, yet it is still impossible to convince the average business man against his will that they would be desirable or profitable in his particular case. In fact, about the only way the average concern can be induced to install them is by the reduction of insurance premiums by 50 to 75 per cent. The building ordinances of most cities offer no encouragement to the would-be progressive citizen, such as limiting areas or heights of buildings except where improved construction or automatic sprinklers are used, and many fire departments are loath to make use of the evident advantage offered by the sprinkler connections, of providing means whereby water may be thrown directly into the heart of a fire, in places and under conditions where no fireman could live. As for the waterworks officials, their ideas may be often summed up as: "All you care to pay for at meter rates, and what is left over for fires." Some water departments, in the endeavor to make a good showing in the ledger account, charge extortionate prices for water supplies for private fire protection, thus nullifying the efforts of the fire department and insurance interests to secure such installations.

In order to determine what rules, if any, have been generally adopted by waterworks officials, the writer communicated with 75 representative American cities, ranging in size all the way from Chicago to Atchison, and in locality from Boston to San Francisco. A series of 7 questions was asked covering the subject. Up to date some 55 cities have replied, with the following results:—

Question A.—Annual charge for sprinkler connections?

Thirty-eight city waterworks and 16 private water companies answered; 34 make no charge and 2 only a nominal charge; 8 cities and 10 private companies charge rentals of from $24 to $120 for 6-inch connections, the cities averaged $44 and the private companies averaged $68.

Question B.—Annual charge for standpipe connections?

Fifty-two answers; 37 make no charge and 2 only a nominal charge; 6 out of 38 city works and 7 out of 14 private companies charge from $25 to $105 per year for 6-inch connections.

Question C.—Annual charge for private hydrants?

Fifty-three answers; 33 make no charge and 2 only a nominal charge; 8 out of 38 city works and 10 out of 15 private companies charge from $22.50 to $105 for a 6-inch connection.

Briefly, these figures show that four-fifths of the city works and one third to one half of the private works make no charge or only a nominal charge for fire connections; the rest charge all the way from $22.50 to $120 for various 6-inch connections, the private companies generally charging the higher figures. Such rates as $105 and $120, which two Western cities charge for connections used only for fire purposes, together with the expense of installation, interest, etc., will go far toward balancing any saving in rates the ordinary property owner would make by installing standpipes or sprinklers, and in effect act to penalize him for reducing his hazard and the exposure to his neighbors. Of course the taxpayer must also pay his share of the general city fire protection.

The fourth question was: Is the size of connections limited?

Fifty cities sent definite answers; of these 17 have fixed no limits, and two limit the connections only by the size of street mains; 7 cities have a limit of 4 inches, 17 cities have 6 inches, 3 cities have 8 inches, and one has 10 inches; two limit to 4 inches, but allow duplicate or multiple connections, and one allows connections of half the capacity of street main. Evidently where any limit is placed there is a decided leaning toward 6 inches as a maximum.

The fifth question concerned requirements for meters on fire connections. Of the 54 cities answering, 30 do not require meters, 13 require detector meters, and 10 require ordinary meters or some kind not specified; one requires none on sprinkler connections, but does on other connections. Briefly, over half do not require meters, one third require detector meters, and the rest other types. This corresponds well with the insurance requirements, that either no meters be used or some form, such as a detector, which will not retard heavy fire flows.

The sixth question concerned requirements for gates and check valves; 48 cities answered definitely, of which 13 have no special rules, and 15 require only one gate outside the building, usually at the street main, but in some cases at curb or building line with a post indicator; 4 require a gate and check vaive, 3 require two gates and a check, 4 require 2 checks, and one requires a gate and 2 checks. Two require checks if pumps are connected, 4 require one check and one requires 2 checks if there is another source of supply. Here is great diversity, but about half of the cities have no rules or only require a gate at the street mains; the rest require also one or more checks, especially if there is another source of supply from which contaminated water might work back into the street mains.

The seventh question concerned precautions against theft of water. Fifty-five cities answered; only 5, none of them private companies, take no precautions; 18 depend upon inspection only, and several find it unsatisfactory; 13 require detector meters, and of these 4 also require valves

and hose connections to be sealed; 11 depend upon inspection and sealing, and the other 8 require seals, ordinary meters, permit no other connection or require owner to give bond not to use water illegally. Here also is great diversity; inspection alone appears unsatisfactory, but in conjunction with sealed outlets seems to work all right; the detector meters appear satisfactory, but are expensive. Several cities state that meters will be installed if any water is used illegally. The experience of the majority appears to be that illegal use of water may be prevented with a fair amount of certainty. Where the detector meters are objected to on account of expense, the prohibition of other connections from fire lines, sealing of test and draw-off valves, hose gates, etc., and regular and careful inspections have been found effective, the property owner would not object to a charge sufficient to pay for monthly inspections or tests.

If thefts of water from the city were regarded just like other thefts, and if persons stealing water were as fairly certain of prosecution as other thieves, and if the citizen that robs the city were regarded in the same light as the one who robs the corner grocery store, we should hear little complaint of this. A Michigan city recently recovered $20,000 damages from a large corporation for thefts of water from an unmetered sprinkler connection and no one knows how much more was stolen. Nobody was prosecuted criminally. Now, if a gang of thieves had stolen that amount from the corporation in question, and the thieves were known to be walking around the town, would not the police and prosecuting attorney fall over each other to put them away securely? But the officers of the corporation in question are "highly respectable" business men; so they are let alone to steal more water, whenever in the course of political events the city shall have a less wide-awake or more subservient mayor and water commissioner.

But to return to the text:—

Suppose the fire chief and the insurance agent have induced Mr. Business Man to install sprinklers at last. How shall they be supplied? The usual sources are:—

1. From a gravity tank above the highest line of sprinklers.
2. From a pressure tank; to be above the highest line of sprinklers if possible.
3. From the public water supply by direct connections.
4. From the public water supply through the fire department hose and siamese connections.
5. From stationary fire pumps, which may be supplied from a stream, reservoir or cistern, or from water mains.

For a standard sprinkler equipment, two sources of supply are required. At least one of these should be automatic and one should be capable of furnishing water under heavy pressure.

The standard rules of the National Board of Fire Underwriters, as recommended by the National Fire Protection Association, state that the pressure connections should be capable of furnishing 25 pounds static pressure at all hours of the day at the highest line of sprinklers, and also

able to maintain 10 pounds pressure on the highest sprinklers with the water flowing through the number of sprinkler heads liable to be opened by fire at one time. This number would probably be all the sprinklers on one floor dependent on one riser. The requirement for 25 pounds static pressure at all hours appears high, and would bar out many cities where the public supply will furnish only 10 or 15 pounds at the top of a 5-story building. This would mean 35 or 40 pounds at the street level, which is a common figure in the large cities and in parts of almost any city. Ten or fifteen pounds will do a whole lot of fire extinguishing where applied directly on a fire, as a sprinkler stream usually is.

The Committee on Fire Prevention of the National Board of Fire Underwriters has for a long time recommended that automatic sprinkler equipments be required in buildings which, by reason of size, construction or occupancy, either singly or combined, might act as conflagration breeders. For such equipments it recommends direct connections from the street mains where pressures are high enough to be effective, with controlling valve in the street.

If the street mains are large enough to provide ample supply, even at low pressure, this is no doubt the most reliable source, next to a detached, elevated tank. How large shall the connections be and how arranged? The N. F. P. A., which is the best authority on these questions, says that for sprinkler equipments or standpipes in built-up districts, 4-inch connections should be used where they will furnish ample water. Usually this can be arranged by dividing the system into two or more sections or taking 4-inch connections from well separated points on the street mains or from different mains on separate streets, as where a building is on the street corner or runs through the block to another street. Where pressures are low or the street mains small, often 4-inch connections will not furnish enough water and 6-inch pipes must be used, as it is well known that the friction loss in 4-inch pipe is about eight times as great as in 6-inch pipe. For standpipes in large buildings, the 4-inch connections do not show up so well; still they are generally quite sufficient.

During a large fire last winter it was seen that the streams from the 4-inch standpipes in the neighboring buildings were ineffective, and this caused the engineers who reported on the fire to recommend not less than 6-inch standpipes for buildings up to 150 feet high and 8-inch for higher buildings. But on studying the report it is noted that 11 streams were in use at one time from the two standpipes which gave poorest results; on reducing to six streams the nozzle pressure was better. The streams from another 4-inch standpipe were reported fair; in this case the couplings would not fit the fire department hose and the presumably inferior hose in the building had to be used. So perhaps good results may be obtained from 4-inch pipes. And if the standpipes must be larger, we can still use the multiple 4-inch connections.

The original theory of sprinklers was that a few heads would open and control a fire at the start, and if a fire should gain headway, or should be

communicated from an unsprinklered building, the sprinklers probably would not hold it. But it was found by experience that liberal supply pipes and ample water would permit the sprinklers to do much greater work; thus, they could protect the centers of large buildings or the upper floors of high buildings or similar areas, which would be out of the range of hose streams.

In many cities where joisted buildings are being but slowly replaced by improved construction, the sprinkler is the chief means by which sweeping fires can be prevented. Even in high fireproof buildings, where contents are combustible, sprinklers are the only means of preventing severe losses; they could have done what no fire department could do: prevented the terrible loss of life at the Asch Building fire in New York.

But there is another feature to be considered. During a large fire pipes will break, water leak out and, if the leak is big enough, the whole public system will be so bled as to make hydrants worthless, and cripple the fire department. So that we must find some happy medium, such size of supply pipes as will not endanger the public supply if broken and yet will be large enough to furnish ample water under working conditions. Then the supply must be safeguarded so that a broken line can be shut off speedily and securely.

Sprinkler experts tell us that in large installations the cost of two 4-inch connections and risers is not appreciably greater than for one 6-inch (except for meters), and the arrangement presents decided advantages, especially the possibility of maintaining partial protection during shut-downs due to repairs or alterations. In some cities we find connections of sprinklers as large as 8 or 10-inch. This is now regarded as bad practice, except perhaps for isolated buildings, from which fires could not spread to other property and where broken mains could be shut off at the street corner without robbing the fire engines of water for the protection of neighbors. For it is evident that a broken 6-inch or larger connection would cripple the fire department in the immediate vicinity until the controlling gates could be closed. Therefore, it is recommended that sprinkler and standpipe services shall have an outside controlling valve set in one of these ways:—

(*a*) At the curb, with an indicator post.
(*b*) At the building line, with an indicator post in a recess in the wall.
(*c*) In a valve pit in the street or at the curb.
(*d*) In bad cases the connection to be looped back and the gate set at the opposite curb across the street, or opposite an adjacent building.

The writer remembers the destruction of a large sprinklered building last November, where the bending of exposed iron work permitted the roof and roof tank to collapse and shortly after the front wall fell into the street, burying the gate valve in front of the building under the wreckage; this prevented the shutting off of the broken 6-inch connection and reduced the pressure in the mains so that direct hydrant streams were valueless and the two nearest engines could not obtain sufficient water. All the fire department could do was to save the surrounding property.

If the sprinkler connection in this case had been at a corner of the building instead of in the center, it would have been a simple matter to close the gate. Sometimes the connection can be gated in front of a stair tower or heavy division wall, where there is less chance of falling walls making it inaccessible.

The fire department should keep track of these connections and be sure that they are properly marked to be quickly located at need. The waterworks men are frequently not available at such times and the prompt closing of a broken connection may make a vast difference in the eventual outcome of a fire. It is not always a falling wall that makes trouble; many things may cause a serious break inside a building—a floor or roof falling, or heavy machinery or safes dropping, and when the break occurs then the sprinkler connection becomes a detriment instead of a help to the firemen. Care should be taken that any main supplying automatic sprinkler systems or standpipes shall be properly gated at each end of the block, so that in extreme cases it will be feasible to cut a short section out of service without interfering with other supplies. In a narrow street the heat of a fire will often render gate valves inaccessible, or in winter the snow may be piled up so they cannot be quickly located.

There should also be a check valve, or preferably two, in the connection between the indicator gate and the riser, so that water will not be drained from the tank during shutdowns of the street mains, etc., and also in case of systems having stationary pumps, so that water, possibly infected with disease germs, may not be pumped back into the street mains.

A recent suggestion for safeguarding fire connections is to place an electrically operated valve in a concrete vault in the street or at the curb. This can be controlled from any distant point, as at each end of the block, or at the nearest fire alarm box, where a small locked box with controlling switch may be placed, the key to be in possession of the fire chief. Then if for any reason the chief should find the sprinkler or standpipe connection taking too much of the supply for his engines, he could at once and with certainty shut them off. Of course, this apparatus must be properly installed and regularly tested; it would seem specially valuable where connections are made to high pressure systems, and the additional expense would not be a deterrent feature compared with the need of certain means of control.

There has been much discussion as to the advisability of allowing connections from high pressure systems for private protection, either to yard hydrants, standpipes or sprinklers. To the yard hydrants there is little objection, if they are made to withstand the high pressures and are regularly inspected like street hydrants. The sprinklers and standpipes are not ordinarily designed for such high pressure, and especially the severe "hammer" or shock caused by sudden increase of pressure. One can imagine what might happen to an automatic sprinkler system if suddenly subjected to the 300 pounds pressure of the New York High Pressure System, or even to 200 pounds. Recent improvement in design

of regulating valves has probably overcome much of this danger, however. These valves may be attached at the gate in the street and set so as to limit the pressure to the sprinklers at any desired figure; they are claimed to be so reliable that pressures may be held within five pounds of the predetermined figure, no matter how much higher the pressure in the street mains may rise. But there is the danger of private connections being so used as to bleed the high pressure system and render it ineffective for fire department use. During the great Dreamland fire at Coney Island in May, 1911, it is stated that over twenty streams were used by adjacent property owners who had standpipe connections, to wet down buildings and roofs. As the total capacity of the Coney Island High Pressure System was only 4,500 gallons per minute, and one of the pumps broke down, leaving only 3,000 gallons per minute during most of the fire, it will readily be seen that few efficient hydrant streams could be obtained by the fire department. On the whole, it seems best to reserve these high pressure systems solely for fire department use and to take no chances of lost pressure in an emergency, unless it shall be found safe to use some combination of electrically controlled gate valves and pressure reducing valves, as explained above. Where the systems are properly designed, with multiple outlet hydrants closely spaced, it is readily feasible to run short lines of hose from the nearest hydrant to the siamese connections of the sprinklers and standpipes, thus giving ample water for severe fires. Any properly designed sprinkler outfit should have sufficient tank capacity to feed the system until the firemen can attach these lines; especially in these days of motor apparatus and speedy response.

To sum up—the experience of many years has proven conclusively that automatic sprinklers are of immense value as fire extinguishers and conflagration stoppers, therefore all should unite in urging and extending their use. To secure best results, a large and reliable supply of water is needful; this in most cases will mean connections to the city water mains. These connections should be large enough to furnish the required supply, but not so large as to hamper the fire department and endanger neighboring buildings in case of breaks.

Both theory and practice indicate that in most cases one or more 4-inch connections properly arranged are sufficient for well designed standpipe or sprinkler systems, and that 6-inch connections are the largest that can be safely permitted in a built up district. Every such installation is of value both in controlling fires originating in the protected premises and in preventing the spread of fires in adjacent buildings.

The waterworks officials should do what they can to encourage such installations by refraining from prohibitive rates and regulations for fire connections, and the fire departments should assist by keeping fully informed as to the location of gate valves and siamese connections, so that in case of fire water may be pumped to the sprinklers so long as these work, and in case of accident gates may be promptly closed to stop leakage of water and loss of supply for the engines.

Electrolysis from Stray Electric Currents.

By Albert F. Ganz.

(Summary of a paper read at the 32d annual convention of the American Water Works Association.)

Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bonding, to ground connections from the negative bus-bar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact which is not generally appreciated, that where large stray currents exist, these can always be reduced to a small fraction of their present value by removing all ground connections of the negative bus-bar, and installing insulated return feeders proportioned for equal drop from radially disposed points in the track system located at some distance from the power station. By this method the rails are drained of current and any desired part of the voltage drop can be removed from the rails and transferred to insulated conductors from which currents cannot leak. In Europe, such radial insulated return feeders for bringing current back from the rails to the power station are made necessary by regulations limiting the allowable drop in voltage in the rails, and in most cases such installations of insulated return feeders have substantially removed serious trouble from electrolysis. This system of minimizing stray currents by means of radially disposed insulated return feeders has also been installed in a number of American cities, and the method is gradually being recognized as by far the best for minimizing stray currents. This system in fact removes the root of the trouble, by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is therefore correct in principle. The railroad companies frequently object to this system, claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities to-day. The fact is that in many electric railways there is practically no installation of negative feeders, and the railway companies are often not willing to install even a moderate amount of return

feeder copper. A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Of course where the negative bus-bar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This however is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit. The railway company can divide the annual charge of interest on copper invested and operating expense in any ratio within wide limits without affecting the amount of stray current produced from the system. The pipe-owning companies suffer constant expense on account of stray railway currents in the form of repairs and depreciation of their underground structures, and in the form of liability for accidents, and this can be reduced with certainty to any desired extent, short of complete elimination, by the assumption on the part of the railway company of expense in the form of interest and power charges for its return circuit. The railway companies should in all fairness assume this expense and responsibility. If the railway companies would apply as much engineering knowledge and money to their negative circuits as they do to their positive circuits there would be but little trouble from electrolysis. The pipe-owning companies should co-operate with the railway companies by affording them access to their pipes for making necessary measurements, etc. After a railway company has installed a reasonable and fair return circuit, it sometimes happens that it is desirable to eliminate any remaining current on pipes by the use of properly located insulating joints. Under these circumstances the pipe-owning companies should be willing to co-operate with the railway company in the installation of such joints.

In the decree recently filed in the celebrated Peoria case, the railway company is enjoined and restrained from injuring the property of the water company by electric current escaping from the rails or structures of the railway company. No particular method for preventing escape of current is prescribed in the decree, because the court in its decision has already stated that a court does not have the power to prescribe by injunction any specific system, and that this power resides only with legislative bodies. In its decision the court however lays great stress upon the insulated radial return feeder system, which is spoken of as a quadrilateral system. The decree also requires the water company to co-operate with the railway company to the extent of giving the railway company access to its piping system for the purpose of measuring flow of current upon its system, and of determining whether injury from electrolysis is being continued, in order that the railway company may determine whether it is complying with the

terms of the decree. It is evident from this decree that the expense of providing a proper return circuit for the railway system so as to minimize escape of current falls entirely upon the railway company as it should in all fairness. One section of the decree states that within six months after the expiration of one year after the date of the decree, the railway company may apply for a hearing on the question whether it should be permitted to make an experimental use of the drainage system, in order to ascertain whether such drainage or limited use thereof can be practically applied to the piping system.

It appears from the decision and the decree that the railway company must within one year improve its return circuit so as to prevent as much as possible the escape of stray electric currents from its systems. If, after this has been done, it is found that stray currents still exist on the piping system, then the railway company may apply to the court for a hearing to determine whether the water company should be directed to permit the railway company to try a drainage system as an experiment to remove the remaining current harmlessly. A drainage system such as contemplated as a possible final measure by the Peoria decree, when properly controlled so that only small currents are drained from the pipes, does not have the objectionable and dangerous features of promiscuous bonding where large currents are made to flow on the pipes as often found in American cities, and may even be a safe final method where the soil conditions are favorable and where the underground structures are all continuous electrical conductors. It nevertheless seems to the author very unfair that any pipe-owning company should be compelled by a court order to permit an electric railway company to use its pipes as a return conductor for its railway system, even to the slightest extent. If the court does not have the power to compel the railway company to adopt any specific method for eliminating the danger from electrolysis, then it certainly should not impose any specific method upon the pipe-owning companies. The latter may for example prefer to remove any small remaining stray currents by means of properly located insulating joints.

It is the author's firm conviction that such remedial measures as pipe drainage or insulating pipe joints should be used if at all only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures. This view appears to be entirely in accord with the Peoria decision, and is certainly in accord with the best engineering practice.

Illuminating Gas, and Its Fire Hazard.

By Thomas W. Roose,

Engine Company No. 6, Boston, Mass.

The object of this paper is to call attention to something that is very generally taken as a matter of course, but which, nevertheless, is a menace to every city in which illuminating gas is used.

There is always something funny about the wording of the newspaper account of the householder who strikes a light to find a gas leak, and is then hurried to the hospital; or when describing what happens when tenants go looking for the "quarter meter" that some unknown person has detached; but the lessons are obvious, and there can be little doubt that few of the buildings having pretentions to being well built could be destroyed with the rapidity with which they so constantly are were it not for the illuminating gas.

It is unnecessary to cite any particular instance from among the many well known destructive gas explosions, many of which, there can be little doubt, were premeditated. The frequency with which they occur, and the extent of the damage they inflict, have long ago called attention to the fact, and should have brought about concerted effort to minimize this hazard.

The matter of preventing fires from illuminating gas has been neglected. We find few precautions enforced, and there can be no doubt that most of our fires obtain the headway they do entirely from this one cause.

We need not consider the technical aspect of the case. The exact quantity of gas that must be mixed with a certain amount of air to exert the greatest explosive effect may be found in any text book, and matters little, for all are familiar with the explosion that follows the application of flame to escaping and slightly confined gas. We have an everyday illustration in the slight report and blaze that follow when we apply a match to the chimney of a gas burner.

There are innumerable ways that gas can be fired and exploded. Gas escaping from broken or leaking mains into the sewers and there ignited by a spark or light is one. Ignition has in many cases been ascribed to lightning. The deflagration that accompanies or follows explosions of this kind is what renders them so destructive; the fire finishes what the explosion began.

Taking the case of any ordinary building on fire, and considering the fragile nature of the gas fittings, we know that some of these things will

soon break or be melted off, thus allowing the escaping gas to increase the blaze.

In practice this is found to be very much the case, and every experienced fireman can remember deluging without appreciable result a mass of flame that appeared to subsist on nothing; and this for a longer or shorter time as the case may happen to be, depending on whether the stream is powerful enough to smother the pipe, or that in some way or another it becomes possible to shut off the gas.

In dwelling house fires this highly inflammable gas when escaping carries the flame through the partitions and between the floors and ceilings so insidiously, and necessitates so much ripping out, that the building is often wrecked before the fire can be controlled.

Much more so is this the case in large buildings where big gas pipes when broken off pour out a practically inextinguishable volume of flame at which streams of water must be constantly directed, often without result, owing to their inaccessibility, or to intervening obstacles.

Nearly every obstinate basement fire is a long hard fight with burning gas escaping from exploded meters and broken pipes, and continuing to burn until the water rises to the pipe, or a luckily directed stream breaks the continuity of the gas and thus quenches the fire;—which will break out again and again every time the gas reaches fire, until the gas is shut off. A basement fire is always difficult to control, and with the complications of illuminating gas it is little wonder that buildings are so frequently lost when fire starts in the basement.

The obvious remedy is to shut off the gas, and when the average person realizes the consequences of gas escaping at a fire he is very likely to wonder why this is not always done, but if you trouble to look for the shut-off cock on any given gas pipe leading to a building, it is a hundred to one shot that you find it in the basement, just where the gas pipe enters the building;—beyond all question the most inaccessible place in case of fire that can be found.

Some buildings have the shut-off cock at the entrance, but more generally it is in the basement. When the building is on fire, and the gas is not shut off, every ramification of the gas system aids the spread of fire, and as the pipes are broken off they pour into the building from their full capacity one of the most inflammable agents we use.

It is true that there are shut-off cocks on the gas mains in the streets: but these are seldom used. This for several reasons: First, from the inconvenience to consumers when gas is shut off from a block or several blocks of buildings; and secondly, because of the danger that necessarily exists when the gas is again turned on a building in which many of the gas outlets are still open, not having been turned off when the lights were extinguished.

A representative of the gas company attends fires in the large cities and is prepared to shut off gas from the outside if it is not possible to do so from the building on fire. It is scarcely necessary to say that this is seldom done.

To shut off the gas from the outside of a building it is sometimes necessary to dig up the street in order to get at the shut-off cock on the main pipe. We know that much precious time must be consumed in finding men and doing this work under the conditions which exist about a building on fire, and we may rest assured that it is seldom done, and that as an inevitable consequence the resulting fire must be drowned out at great damage to the building and contents, and often with irreparable damage to both before the fire is controlled.

As an aid to arson illuminating gas proves one of the most insidious and effective agents ever devised. To anyone who has the opportunity and will but trouble to observe, particularly in the tenement house districts, it is obvious that the application of illuminating gas as an agent for arson is thoroughly understood and often applied. A fire started under a gas meter makes almost certain the destruction of the place. For the purpose of the incendiary this gas furnishes a ready, powerful, and practically undetectable means to the end and whoever has once seen the great burst of flame that so often accompanies or rather, announces the destruction of small overstocked stores in these districts, must have had great difficulty in reconciling his observations with any other supposition than that gas escaped, accidently or otherwise, and that in due time it came in contact with a convenient flame. In view of the fact that these fires so often occur on thoroughfares along which crowds are incessantly passing, it is obvious that there are few other agents that could be used and not permit discovery before the fire is sweeping half way across the street.

There can be little doubt that the rapid spread of the fire in tenement houses by which the escape of the inmates is cut off and lives are so often lost is directly attributable to exploding meters which allow the gas to spread the flame.

However, it is not so much these minor affairs that are a source of grave apprehension, as is the factor of illuminating gas in contending with great fires; for it cannot be doubted that at a great fire the immense quantity of gas liberated from thousands of broken pipes materially aids the conflagration.

As a matter of fact, most of the great fires in this country have been essentially gas fires, many of them originating from that source, and nearly all of them rendered a thousandfold worse by that agent. Certain it is that there were constant gas explosions during those conflagrations.

The great New York fire of 1835 began at No. 25 Merchant street. From this building the report of an explosion was heard, and with the rapidity of lightning fire shot up, the building being a mass of flame when first observed from the street to the fourth floor. The Commission appointed to investigate this fire decided that it began with an explosion of illuminating gas.

The great Chicago fire of 1871 was greatly spread by escaping gas, and objectively, beyond question, when the fire approached the huge gasometer, and the valves were opened to allow the gas to escape freely and thus avert an explosion, with the result that the escaping gas soon caught

fire and streaming down the wind in gigantic flames set fire to buildings far to leeward until the terrific explosion came that wrecked the gasometer and destroyed everything in its vicinity.

There is overwhelming proof that to a very large extent illuminating gas caused the spread of the great Boston fire of 1872. Repeatedly asked to do so, the gas company refused to shut the gas off the city; though efforts, more or less futile, were made to shut the gas off from the portion of the city that was on fire.

From a certain point of view this refusal was justified, for to leave the city in darkness at that time was to afford opportunity for every conceivable crime. The situation was bad enough without that, was the argument, and that all purposes would be answered by shutting the gas off from the part of the city that was on fire.

Under the conditions there existing it was impossible to do much in the way of shutting off gas. The gasometers continued to supply gas, and as an object lesson to future times fiery pillars of gas continued to flame from the ruins long after every vestige of combustible matter had disappeared from the buildings themselves.

On the day following the big fire gas explosions frequently occurred, blowing the manhole covers of the sewers high in the air; and on the evening of that day an explosion of gas in a building on Summer Street blew out the front walls, and lighted again the flames in its vicinity, which again threatened the city, and were not controlled till they had consumed the fine block in which the explosion occurred.

How great a factor illuminating gas proved in the $125,000,000 fire in Baltimore, Feb. 7–8, 1904; in the $500,000,000 ash heap following the earthquake at San Francisco, April 18, 1906; and in the rapid sweep of flame across Chelsea, Mass., April 12, 1908, can only be conjectured. In all probability the explosions that marked the beginning and accompanied the Baltimore conflagration were caused by gas; and there can be no doubt that at all our great fires the lack of ready control over the supply of illuminating gas has been an element all but decisive against the operations of the fire departments.

The corrective to this state of affairs is simple, and should long ago have been enforced. Every building to which illuminating gas is piped should have a shut-off cock at the entrance, or outside in an easily accessible position, so that when the building is on fire the gas can be shut off by the first firemen that arrive.

The building regulations of a few cities wisely provide for the installation of a shut off appliance for gas on the outside of some buildings. That so sensible a regulation is not applied to all buildings and included in the building laws of all cities is the strangest omission in our municipal laws; and as long as illuminating gas is used, and adequate means are not provided to shut that gas off from buildings on fire, so long must we contend with immense volumes of incandescent gas, and so long will illuminating gas continue to be one of the greatest of our hazards.

The Manufacture of Illuminating Gas and its Hazards.

By Stephen Lawrence Burgher (Member N. F. P. A.).

Illuminating gases as manufactured in the United States are principally of two varieties, known as water gas and coal gas. Based on the latest available figures of the United States Geological Survey, the total gas sold in this country per year is as follows:—

	Cubic feet.
Natural gas	140,584,000,000
Manufactured gas	157,211,000,000
Total	297,795,000,000

The manufactured gas is divided as follows:—

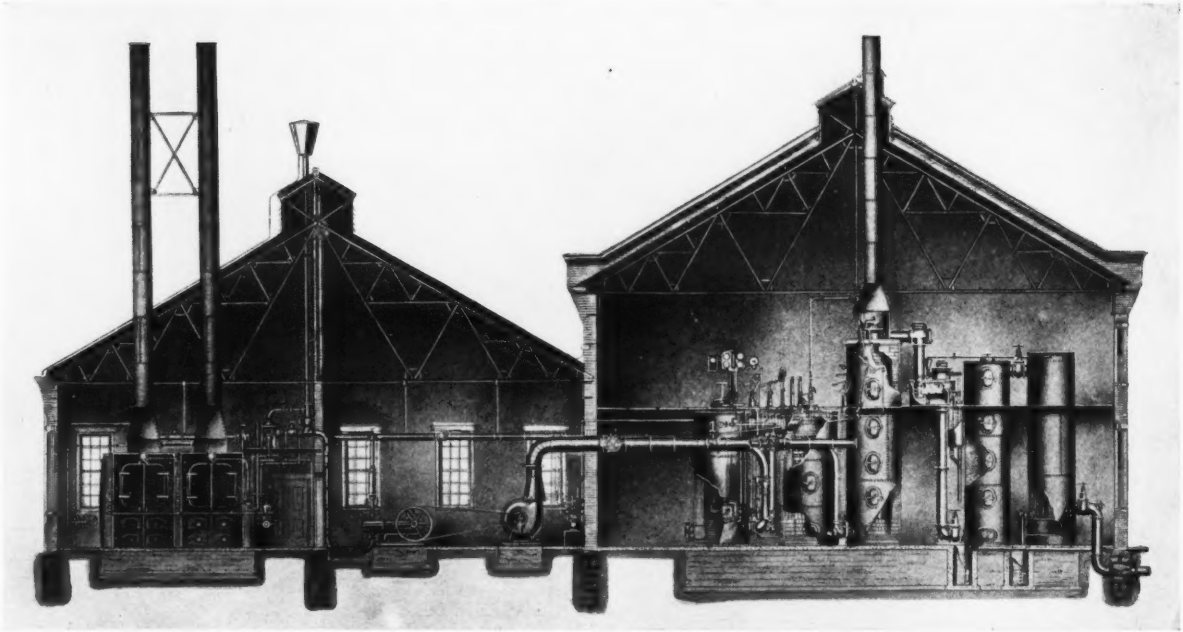
	Cubic feet.
Coal gas	45,000,000,000
By-product coke oven gas	9,000,000,000
Water gas	103,000,000,000
Acetylene gas	23,000,000
Gasolene gas	188,000,000
Total	157,211,000,000

Leaving out of consideration the acetylene and gasolene gases, the latter covering the numerous methods of diluting light oil vapors with air, it is apparent that approximately two thirds of the manufactured gas sold in the United States is water gas. Approximately the other third is coal gas, and as these two gases form such a large part of the manufactured product, the others will not be considered in this article.

Statistics on the manufacture of gas taken from the thirteenth census of the United States in 1910 show that there were 1,296 establishments, having an invested capital of $915,537,000, and in which over 51,000 persons were employed. The value of the annual production of these plants was $166,814,000.

Water Gas.

In describing the manufacture of this gas, the Lowe system of manufacture will be followed, as that system is the one that is used to the great-



Boiler Room. Blower Room. Generating Room.

Water Gas Plant.

est extent. Few of the other processes of manufacturing this gas have attained any degree of importance, although several modifications of the Lowe system are used. These modifications are for economizing on ground area, and consist mainly of superimposing the carburetor and superheater to form one machine.

Water gas is the product of the decomposition of water, in the form of steam, in contact with incandescent carbon. Water is a chemical compound of two gases, hydrogen and oxygen, in the proportion, by volume, of two parts hydrogen to one part of oxygen. Incandescent carbon has a strong affinity for oxygen, uniting with it to form carbonic oxide.

The result of this reaction is a mixture of two gases, carbonic oxide and hydrogen, theoretically in equal volumes. Under ordinary working conditions a very small amount of carbonic acid is also formed, thus slightly reducing the proportion of carbonic oxide.

This mixture of carbonic oxide and hydrogen is known as non-luminous or "blue" water gas, and has a calorific value of approximately 300 British thermal units.

The fact that water could be decomposed in the presence of incandescent carbon has been known for more than one hundred years. In 1780 an Italian named Fontana published the results of his experiments with this reaction.

Commencing with 1824, attempts were made to carburet or enrich non-luminous water gas and make it suitable for illuminating purposes.

The first attempt to manufacture and distribute carbureted water gas, on a commercial scale, was made by Michael Donovan in 1830. The blue water gas was carbureted with volatile hydrocarbons, and this gas was experimented with for lighting the streets of Dublin. The scheme was not a success.

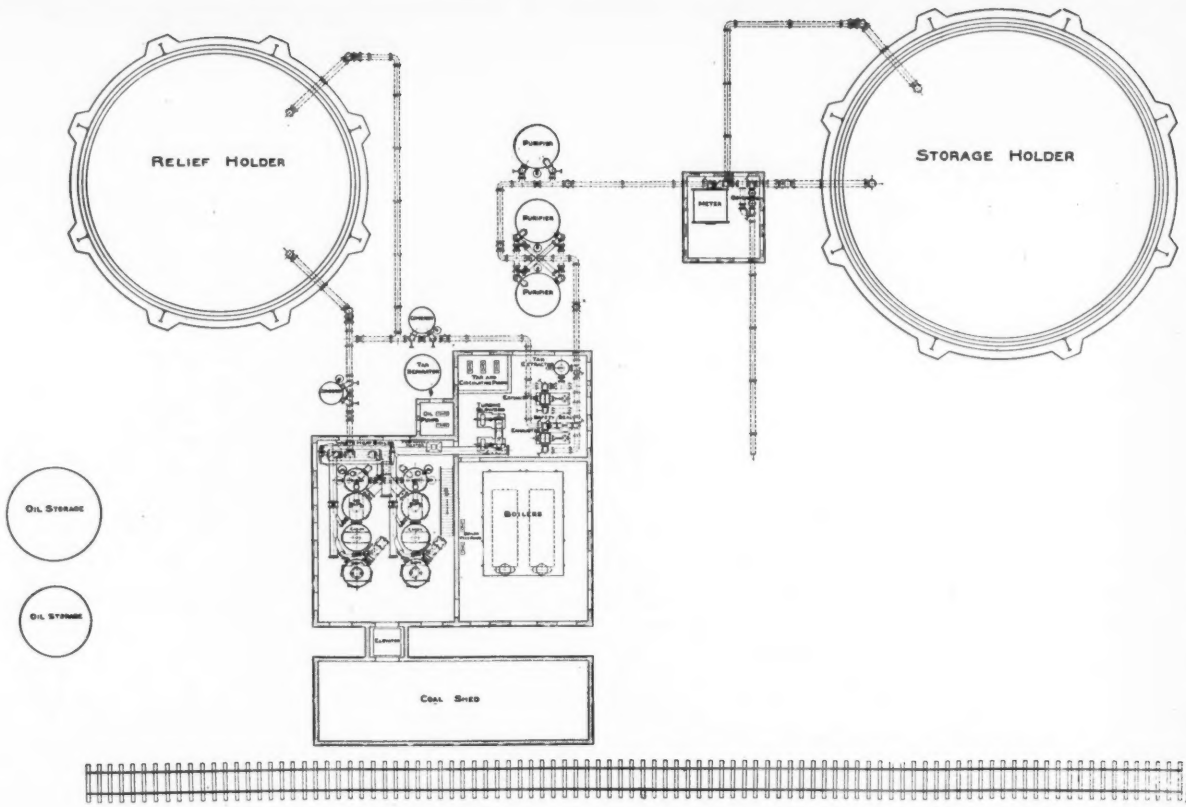
Another attempt was made in 1846 by J. P. Gillard, but this also proved unsuccessful. In the next forty years no less than sixty patents were taken out for methods of manufacturing and carbureting water gas.

The discovery and development of the oil fields of Pennsylvania and Ohio and the invention of the generator-superheater apparatus by Prof. T. S. C. Lowe of Philadephia, Pa., made possible the successful and economical production of carbureted water gas.

During the early years of the development of the Lowe apparatus, a number of methods and processes for manufacturing carbureted water gas were experimented with. In some cases temporary success was attained. The earlier and cruder methods were based on the utilization of apparatus of the coal gas type, making water gas in externally heated retorts or chambers.

The next step in advance was to combine a generator for producing blue water gas with a system of externally heated retorts for fixing the oil vapors. In both of these methods, it was necessary to use a light oil, generally naphtha.

The latter produced a gas of good quality, but the apparatus was



Typical Layout for Large Water Gas Plant.

complicated, expensive, and lacked flexibility. From the fire hazard standpoint it was dangerous.

The basic principles of the Lowe system are the use of a generator and superheater, both iron shells lined with fire brick, the former being provided with grate bars, air blast and steam connections, the latter being filled with loosely piled checker brick to give fixing surface.

In the generator, non-luminous water gas was produced by the dissociation of steam in contact with carbon (in the form of anthracite coal) previously heated to incandescence by means of a forced blast of air. The superheater was brought to a suitable temperature for breaking up and fixing oil vapors by the combustion within it of carbonic oxide formed during and by the passage of the air blast through the fuel in the generator. Oil was introduced into the superheater coincident with the generation of non-luminous water gas in the generator, and by contact with the heated fire brick surfaces the oil vapors were gasified and fixed in the presence of non-luminous gas and during their passage through the superheater. The process is intermittent; first a period of blasting to bring the carbon in the generator to the proper temperature, and by complete combustion of the blast gases in the superheater to bring the checker brick to the proper temperature for fixing the oil vapors; second, a period of gas production.

The early forms of the Lowe apparatus were designed for and only suitable for the use of naphtha for carbureting. At that period naphtha was a product of the distillation of crude oil, for which there was little demand or use; and the oil refiners had great difficulty in disposing of it. Its utilization in the manufacture of gas meant economic progress.

In the course of a few years, however, newly discovered uses for naphtha increased the demand for it to such an extent that its availability for gas making purposes was threatened. The design of the Lowe apparatus was then improved so that crude oils could be used efficiently. One of the most important features of these improvements was the addition of another superheater, thus evolving successfully what has been known since as the "double superheater" apparatus, which has become standard in water gas manufacture.

The increased demand for crude oils made it necessary to use a by-product for which there was no particular demand, for a carbureting material. This became known as "gas oil." The apparatus was later developed to use Texas oils, which are rich in sulphur, and also gas-house coke as well as anthracite coal.

The materials that can be and are used at the present time in the generator are: gas-house coke, by-product coke, oven or beehive oven coke, Pennsylvania and Welsh anthracite coals. It is known that in one case sawmill refuse has been employed. For carbureting materials: gas oils or crude oils are used. In case of emergency, naphtha and other similar distillates can be used successfully.

The gas-making apparatus consists of three separate upright shells placed on the same foundation level and connected so as to practically

form one continuous vessel. The first is the generator; the second, the carburetor, and the third the superheater.

The generator and carburetor are connected together near the upper heads; the carburetor and superheater are connected near the bottom, these connections being lined with fire brick. The tops of both generator and carburetor are at the level of the working floor. The superheater extends about seven feet above this floor.

Each of these three shells is lined with fire brick. In smaller sets the generator only is double lined, while in larger sets all three shells are double lined. The interior of both carburetor and superheater is filled with fire brick, placed loosely in tiers, in such a way as to break joints and baffle the gas in its passage through, thus keeping it in more intimate contact with the heated surfaces.

In the operation, the generator being filled with a deep fire of coke or coal, a blast of air from a blower is admitted in the bottom of the generator, underneath the grate, and passes through the fuel. The oxygen of the air unites with the heated carbon to form carbonic oxide. The nitrogen is not affected. These two gases, carbonic oxide and nitrogen are termed the products of partial combustion, the meaning of which is that if more oxygen be added, the carbonic oxide will ignite and burn to carbonic acid. These products of partial combustion are thus burned in the carburetor and superheater by admitting air from the blower. The result of this combustion is intense heat, which is taken up by the loose fire brick, or checker brick with which the carburetor and superheater are filled. The resulting carbonic acid and nitrogen,—products of complete combustion,—then pass off to the atmosphere through a stack valve. The degree and distribution of heat in the carburetor and superheater are entirely under control and can be adapted to the character of the oil used in the carburetor.

When the temperature in all shells is at the proper point, shown by electric pyrometers, the air blasts are shut off and all combustion ceases.

The stack valve is then closed and steam is admitted under the grate in the generator. The passage of this steam through the highly heated fuel produces non-luminous water gas. As this gas enters the top of the carburetor, it meets a spray of partially vaporized oil. The gas and oil vapors pass together over the highly heated surfaces of the carburetor and superheater and the oil vapors are gasified and fixed in the presence of non-luminous water gas. The result is a thoroughly fixed and permanent illuminating gas. When the heat is reduced to a point where it is no longer advantageous to continue the run the oil and steam are shut off, the stack valve is opened and a period of air blasting takes place.

The gas then passes for purification and storage. From the superheater, near its top, proceeds the gas outlet pipe, leading down to a small vessel which acts as a tar extractor and in which the end of the gas outlet pipe is sealed in tar. In the vertical outlet pipe is placed a smaller pipe, through which the oil passes on its way to the carburetor, being heated

by the hot gases, and entering the carburetor in a partially vaporized state. The gases, after dipping under the tar seal and having much of the tarry matters extracted, due to the lowering in temperature of the gas, pass into a scrubber and a condenser and thence out of the house to a relief holder in the yard.

The scrubber is a vessel about six feet in diameter and twenty feet high. The gas enters the bottom of this under a water seal and passes up through a checkerwork of bundles of wood over which water is sprayed at the top. The condenser consists of a large upright cylinder filled with two-inch pipes through which cold water circulates, and around which the gas passes. This lowers the temperature of the gas and like the scrubber causes further separation of tar. All tar finds its way to the tar well, usually provided underground, where the water and tar are separated and the tar, in many cases, used for boiler fuel for generating steam. The oil tars thus obtained are not so useful for commercial purposes as the tars obtained from coal gas manufacture which are sold as a by-product.

The object of the relief holder is to change the intermittent feature of production to one of steady and constant flow throughout the remaining processes. In some plants the relief holder is weighted in such a way that the gas is forced, instead of being pumped through the remaining apparatus.

From the relief holder the gas goes through a large upright cylindrical vessel, called the shaving scrubber, as contrasted from the first scrubber sometimes called the washer scrubber, which is filled with dry wood shavings. The action in this scrubber is to take out all moisture and what little tar remains in the gas.

The gas, at this stage, is not fit for distribution, as it contains impurities, those which it is necessary to remove being carbonic acid and sulphureted hydrogen. Therefore, the gas is passed through the "oxide purifiers," which are large, shallow, cast-iron, box-shaped vessels filled with screens. The gas passes up through these screens which, being covered with a mixture of iron filings, soft wood and sometimes slacked lime, remove the impurities mentioned above. When the purifying action has ceased, simply exposing the inert mixture to the action of the air for a while restores its properties until after repeated use it becomes so charged with free sulphur that it is no longer serviceable.

When the use of sawmill refuse known as "cypress hog" or "pine hog" is employed in the generator, the dry scrubber and even the tar extractor may be omitted, as there is very little tarry matter in the gas.

From the purifiers the gas passes through meters to the storage holders, ready for distribution.

Coal Gas.

The discovery that the distillation of coal and other carbonaceous substances produced an inflammable and more or less luminous gas was made prior to 1690, but it was not until nearly one hundred years later

that the idea of using this gas for illuminating purposes was conceived. Then this use seems to have been thought of independently by several persons in different countries at about the same time, and consequently there is a dispute as to who should be accredited as having been the originator of the use of coal gas as an illuminant.

Apparently J. P. Minckelers, a professor in the University of Louvain, in Belgium, in 1784, distilled powdered coal, for the production of inflammable air which he used to fill balloons. In a report advocating the use of coal gas for aeronautical purposes, in which he was particularly interested, he is said to have mentioned the fact that the gas might be purified by being passed through lime water and could be used for illuminating purposes. It is also claimed that records in the archives of Louvain show that in 1785 Minckelers lighted his lecture room with inflammable air produced by the distillation of coal.

The earliest patent taken out in England, in connection with the distillation of coal, was that of Lord Dundonald, for the production of different substances from the distillation of coal, obtained in 1785. His object, however, was the production of tar, and while he is said to have lighted the hall of Culross Abbey with crude coal gas in 1787, he apparently did nothing further along the lines of illumination by means of coal gas.

William Murdock, who is credited as being the originator of the use of gas for illuminating purposes, apparently began experimenting along this line at Redruth, Cornwall, in 1792. In that year he distilled coal, peat, wood and other carbonaceous bodies, and being impressed by the quantities of gas given off during distillation and the facility with which a brilliant light was produced by this means, he made experiments to determine the relative costs of light so obtained and that obtained from oils and tallow. In 1797, he lighted his own premises with coal gas and later other buildings.

The man, however, who probably was the greatest factor in hastening the introduction of the public supply of gas was Frederick A. Winsor. He was struck with the possibilities of the process, and after much labor and time promoted a National Light and Heat Company in London in about the year 1808. In 1809 he lighted with gas a portion of one side of Pall Mall, this being the first public street lighted by means of coal gas. Even with the crude apparatus used in these times it was found that lighting by means of coal gas was much cheaper than by means of candles, which was the general practice at that time.

By 1815 the London and Westminster Chartered Gas Light and Coke Co., also formed by Winsor and his associates, had installed three manufacturing plants and fifteen miles of street mains. Other companies were soon organized and the business of supplying gas progressed so rapidly in Great Britain that in 1829 more than two hundred gas companies had been formed.

The first use of coal gas as an illuminant in the United States is said to have been made in Philadelphia in 1796, but the first definite record

of such use in this country is the lighting in 1806 by David Melville of his house in Newport, R. I., with gas made by himself. In 1813 he lighted with gas some mills in the vicinity of Newport.

The first gas company in the United States was organized in Baltimore in 1817, and this was followed by the organization of companies in Boston and New York, but because of the comparative cheapness of other illuminants progress was slow, and up to 1830 these were the only cities that had gas works.

Coal gas as manufactured for illuminating or heating purposes is made by the destructive distillation of coal in retorts externally heated.

The classes of coal used for the purpose are confined to those varieties which are bituminous in their nature, yielding, upon distillation, the greatest possible amount of volatile hydrocarbons. Bituminous coals have the property not possessed by the anthracites, of softening and apparently fusing when subjected to a temperature below that at which combustion would take place. Coals having a large percentage of hydrogen yield more volatile substances at the temperature of distillation and less carbonaceous residue than others which contain less hydrogen and more carbon, the latter approaching anthracite in composition. Anthracite is therefore valuable for the manufacture of water gas, as it contains larger amounts of carbon.

There are two classes of coals which are bituminous in their nature called "coking" and non-coking coals. These are much the same in composition, but the latter does not possess the quality of fusing to a compact mass and is therefore used for steam boiler firing.

As the coking coals which are used in coal gas manufacture come in large lumps, it is necessary to crush them into small pieces before being used in the retorts.

The retorts as made in recent years are universally of some form of fire clay. Older retorts were made of cast iron, but the destructive action of the gases made the use of clay retorts a matter of economy in maintenance. These retorts are usually of the shape of a capital letter "D," with the flat side for the bottom. But retorts of oval or even circular shaped cross-section are often used. The dimensions vary, but are very often as follows: width internally, 20 inches; height internally, 13 inches; thickness of walls, 3 inches, and length about 20 feet. These are mounted, five to nine in a set or bench, horizontally, vertically or inclined at an angle of about thirty degrees with the horizontal in brick furnaces of special construction, in such a manner that the gases of combustion of the fire beneath pass around and over the retorts and out through a main flue leading to a chimney. The fuel for firing is usually coke taken from some of the retorts above after the run. Sometimes coal and in a few cases gas is used for heating the retorts on the regenerative principle.

The retorts are filled with gas coal in amounts ranging from 200 to 1,000 pounds, according to the size and serviceability of the retorts, and allowed to heat for five or six hours. The heat drives off the volatile

gases which form the basis of illuminating coal gas and leaves coke in an incandescent state. The coke is drawn out of the retorts into a trough usually fitted with a conveyor which carries it under a water spray to cool it before finally dumping it in the yard.

Retorts are charged by hand, care being taken to distribute the coal evenly over the bottom of the retort. Inclined and vertical retorts are charged from their upper ends and drawn from the lower ends. Mechanical means of charging have been devised, but were not found to give the best results and are therefore not used.

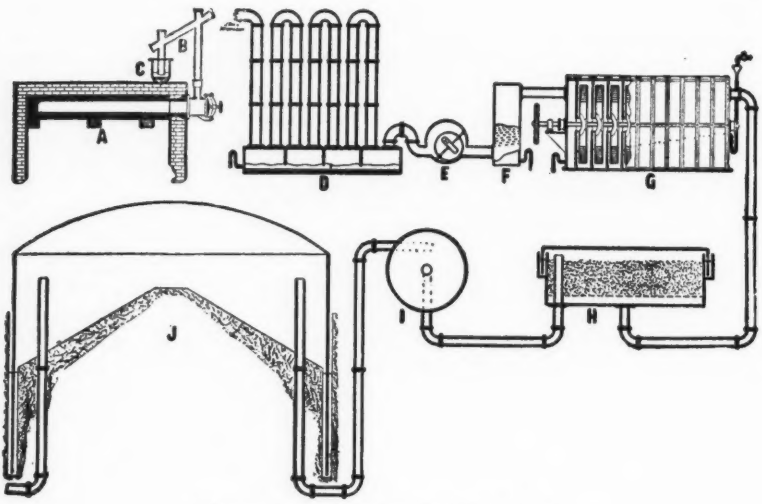


Diagram of a Complete Coal Gas Plant.

From the retorts "A" (see sketch) the gases pass up a pipe "B" called the "standpipe," with which each retort is provided. The outlet end of the standpipe dips below a water or weak ammonia liquor seal in what is termed the "hydraulic main," "C." The passage of the gas up the standpipe and through the seal lowers its temperature and causes the main bulk of the tar and ammonia to be left in this liquor. A large drum is attached below the hydraulic main of each bench and in this the tar collects. Overflow pipes from the tar drum and the hydraulic main conduct the tar and ammonia liquor to the tar well, wherein the products collect.

From the hydraulic main the gas, somewhat purified, passes to another building, and into a condenser "D," usually of an upright type, which contains tubes through which cold water circulates and around which the gas passes. Newer forms of condensers, known as atmospheric condensers, as shown in sketch, are composed of vertical pipes connected

in pairs near the top, the lower ends being connected to a box containing water and which is divided by partitions so that the gas passes over the water and up and down the pipes alternately. The reduction of temperature of the gas in the condenser throws out more tar and ammonia which find their way to the tar well.

The gas at this stage usually passes through an exhauster or pump "E" which draughts from the condenser. The gas has flowed from the retorts to the condensers due to the sucking action of this pump. From this stage on the gas is under a pressure of about five or six inches of water and is forced through the remaining apparatus to the storage holder.

The gas sometimes becomes heated again, due to the compressing action of the pump, and it is sometimes necessary to put it through another condenser to lower its temperature again.

The gas then passes through a tar extractor "F" which takes out more tar and ammonia. The gas enters an upright cylindrical vessel under a water seal and passes up through screens or grids arranged so as to baffle the gas in its passage through them. This action removes all tar that remains.

From the tar extractor the gas goes to one or two scrubbers "G" for the purpose of separating the naphthalene and ammonia that remain, and these machines also extract a small amount of the sulphureted hydrogen. Two principal forms of scrubbers are in use: the tower scrubber and the more compact washer scrubber. The tower scrubber consists of a tall shell packed with coke, wooden checker work, or perforated iron plates, down through which a weak ammonia liquor trickles and meets the gas passing up. The washer scrubber "G" (shown in sketch) is either upright or horizontal and consists of numerous segments in each of which a shaft revolves. Bundles of wood are attached to the shaft in each segment and on a portion of the revolution these pass through a weak ammonia liquor. The gas passages are so arranged that the gas must go between the small spaces in the welted bundles of wood.

From the scrubber, the gas passes to the oxide purifiers "H," as in the purification of water gas, and this removes the hydrogen sulphide still remaining, carbon disulphide and carbonic acid. The gas then is passed through meter "I" and to storage holders "J" ready for distribution.

A new system recently brought to notice has been installed in Derby, Conn., employing vertical retorts. This is known as the Woodall-Durham system, and the advantage claimed is that gas may be made continually by the use of automatic machinery. This is a new undertaking, and if proven successful will probably be used extensively in new plants.

In General

A great many plants manufacturing illuminating gas make both coal and water gas, though newer plants apparently tend toward water gas as being more economical in that less labor and less yard room are required. Water gas apparatus has also the advantage of being more flexible, as gas

can be produced from an idle plant in about twenty-four hours, while in coal gas plants it would take from one week to one month. For this reason, water gas is made in coal gas plants to take care of seasons of heavy consumption by their customers. The gases are mixed in the mains in various percentages, although pressures, etc., must be carefully regulated when they are mixed, as they are of different specific gravities.

Coal gas plants have coke and tar as by-products. The ammonia liquor also is sometimes sold direct as a by-product and, sometimes, by distillation and surface contact with sulphuric acid, it is reduced to ammonia sulphate and sold in that form.

Coal gas, as a by-product of coke manufacture is also sold for illuminating purposes, both in the purified and in the unpurified state. The retorts or coke ovens used for manufacturing coke are very large and are heated for about thirty hours. Part of the gas obtained is usually used for heating the ovens and what remains is sold to companies who purify and distribute it. Methods of purification, etc., are the same as for the ordinary coal gas.

Hazards.

In considering the hazards, the construction of various buildings is important. These should all be fire-resistive if possible. In any event, there are certain places which must be fire-resistive on account of the nature of the occupancy.

One of these places is the operating floor of the generator room of the water gas plant. This floor comes on a level with the top of the generator and carburetor and is subjected to considerable heat. A good form of construction for this floor and one that is often found is iron plates laid on steel "I" beams. The roof of such a generating building should also be fire-resistive and in any event the stack above the superheater must be well protected against any woodwork. A good form of construction for the roof of the generating building that is being adopted is corrugated iron laid on steel truss work.

The places corresponding to these in the retort house of a coal gas plant are the drawing and charging floors and roof. As coke is drawn from the retorts, it is liable to fall in all directions before being carried away by the conveyors. This necessitates a fire-resistive form of construction for these floors. The conveyors must be of metal and must not come near woodwork, as the coke is in an incandescent state as it leaves the retort and heats the metal of the conveyor. These conveyors are sometimes run in a trough filled with water.

The danger of spontaneous ignition of coal in a gas plant is probably no greater than in any plant using steam boilers. The coals used in the actual production of gas are not liable to heat spontaneously, as anthracite is used in water gas plants, and gas coal which comes in large lumps is used in coal gas plants. Neither of these coals is considered dangerous.

The purifying process by the use of oxide is one in which there is

considerable hazard. Iron filings are almost universally used and these in storage are liable to heat spontaneously. Their storage should always be in a cut-off section, perfectly fireproof. The action in the purifying boxes is one that will cause spontaneous heating if allowed to take place too rapidly. Then, when the covers are removed for recharging, there may be heat enough in the sponge to ignite the gas which must necessarily be contained in the boxes and thus cause an explosion. Another cause for heating in the boxes is apt to occur from improper mixing of the iron filings and wood shavings, so that a quantity of filings remains closely packed together. These troubles are not likely to occur in a mixture that has been used several times, as the chemical actions take place more slowly under that condition. The reviving process is usually done on the floor below the boxes. The oxygen of the air unites to separate free sulphur. This action is also a cause for spontaneous heating if carried on too rapidly, and for that reason all windows, etc., in the reviving room should be closed so that the action will take place slowly.

Recently purifying boxes are being made larger so that one box takes the place of several smaller ones, and these are being laid in open yards partly underground, with only a roof covering for protection. This form is much more desirable than having the purifying boxes located in buildings.

Other processes that need special attention are: the storage and immediate removal after use of the shavings used in the shaving scrubbers, and the storage of lime and gas oils which should be at an ample distance from all buildings.

The method of feeding gas oil to the carbureter should also be considered. The safest method, from a fire hazard standpoint, is to employ pumps which draw from a storage tank outside. In case of a fire or damage to the pump the oil in the pipes will drain back to the storage tank. A system of feed by gravity from tanks located above the carbureter would allow all the oil in the tank to drain into the building in case of a break in a pipe. In this system, all oil piping should be located where it is least liable to breakage.

The arrangement of gas piping should be such that there is the least possibility of breakage, as a leak might liberate an enormous quantity of gas. Piping laid underground as much as possible is desirable from the fire hazard standpoint. It is also well to have at least two shut-offs in different locations for each section of piping, as it might be impossible to operate one valve in case of trouble caused by a broken or leaking pipe.

The possibility of gas leakage is present continually during the process and especially in the generator building, condenser building, purifier room, meter room, valve and governor rooms. For this reason open flames and smoking should be prohibited and all electric lighting should be installed as recommended by the National Fire Protection Association for localities where volatile inflammables are present by using double encased lamps, conduit wiring and outside switch control.

Another hazard occurs in the testing of the manufactured gas for its

candle power or illuminating quality. The usual method employed for this is by ordinary photometric apparatus with open flames, one burning the gas to be tested and the other a standard of illuminating power at either end of the machine. The standard light formerly used was the common candle, but of recent years the "Harcourt Pentane Standard" has come into use. The standard in this case is obtained by mixing the vapor of pentane with air and burning this mixture. Pentane is a hydrocarbon of the menthane series and is very volatile and highly inflammable. It is much more hazardous than gasolene, in that its evaporation is more rapid. It is placed in an elevated tank holding about one pint. The hazard lies in the presence of open flames and matches which are usually employed to light the flames in a small room in which an inflammable volatile liquid is freely used and stored. For the best possible arrangement the testing should be in a detached fireproof building with electrical apparatus for lighting the flames. Also all storage of pentane should be away from any building and the ventilation of these dark rooms should be investigated, as the vapors are heavier than air.

With acknowledgments for cuts and valuable information to Frank Hall Thorp's *Industrial Chemistry*; United Gas Improvement Company's *Carbureted Water Gas*, and Alfred E. Forstall, *The Technique of Gas Manufacture.*

Department of Fire Record.

By J. Albert Robinson, Superintendent.

The Dip Tank Hazard Fire Record.

In a study of 771 benzine fires which includes our complete record to February 1, 1913, it was found that 10.5 per cent of these were due to the dip tank hazard. Of these benzine fires in which automatic sprinklers operated, 14.2 per cent were due to this hazard. This shows that the dip tank hazard is a real one and worthy of a careful investigation There were 2.7 per cent sprinkler failures in the total benzine fire record, and none among the dip tank fires. This is a surprising testimonial of sprinkler protection under admittedly adverse conditions. It is an interesting fact that, whereas about twenty per cent of the benzine fires occurring in sprinklered properties were extinguished before the sprinklers operated, only 5.5 per cent of the dip tank fires were extinguished in like manner.

These dip tank fires were distributed among the following occupancies: Metal Workers, 32; Agricultural Implements, 13; Furniture Factories, 10; Electrical Appliances, 4; Wagon and Carriage Factories, 4; Miscellaneous Woodworkers, 3; Sheet Metal Workers, 3; Machine Shops, 2; Foundries, 2; Car Barns, 2; Miscellaneous, 6, as follows: Willow Basket Factory, Corset Works, Trunk Factory, Jewelry Shop, Sporting Goods Manufactory, and Plating Works.

It is a lamentable fact that the largest single cause of dip tank fires was matches. Over twenty-seven per cent of the fires were due to this cause. Open flames of various kinds caused over one-fourth of the fires. It is also important to note that about fifteen per cent of the fires were caused by electric sparks, either in apparatus or by breaking incandescent electric lamps. A close examination of the causes is sure to impress one with the fact that a large percentage of them were due to absolute carelessness and thoughtlessness, and that very few were due to purely accidental or unforeseen acts or conditions.

Fifty per cent of the fires were practically or entirely extinguished by the sprinklers, and fifty per cent held in check. As these averages for all sprinkler fires of which we have record are about sixty-four and thirty-one per cent respectively, this would seem to show that the nature of the hazard now under consideration was a decided factor in modifying the usual relative results in fire extinguishment.

The average pressure in those cases where the fires were practically extinguished was sixty-six pounds, and fifty-five pounds in those where the fire was held in check. In the cases where no claim for insurance indemnity resulted, the average pressure was sixty-one pounds; in those where the loss was small sixty-two pounds; and fifty-six pounds where the loss was large. These are good average pressures for satisfactory sprinkler operation and they do not show any marked variation as related to the success of the sprinklers or the amount of loss. Probably, owing to their quick flash and hot nature especially high pressures are not so apt to be a factor in this class of fires as they are in fires that originate in a less vigorous and explosive manner.

An average of about twenty-nine heads opened in all cases, and excluding four cases where more than one hundred heads operated in each, the average is seventeen heads. Less than ten per cent of these fires were extinguished with one head, one-third the average number for all our recorded sprinkler fires. About thirty-five per cent of these fires were extinguished by five heads or less, which is about one-half of the average number for all sprinkler fires. The number extinguished by ten heads or less is about twenty-seven per cent less than the average, and even the number extinguished by twenty-five heads or less is about twenty per cent less than the average for all sprinkler fires.

In the cases where the fires were extinguished an average of twenty-five heads opened, and an average of thirty-four heads opened in the cases where fire was held in check. In the cases where no claim for insurance indemnity resulted, the average number of heads which opened was ten; where a small loss resulted the average was fourteen; and where a large loss resulted the average was ninety-one heads per fire. The average for the latter is forty-eight heads, excluding the four cases where more than one hundred heads operated. These results show that large demands are made on sprinklers in this kind of fire; therefore, ample supplies are more important than heavy pressures. Pipes and sprinklers should be arranged and located with care to deliver the greatest amount of water in the vicinity of the dip tanks, with the least amount of friction losses.

Forty-two per cent of the fires occurred in plants equipped with dry systems. A study of the success and operation of such systems under the trying demands of dip tank fires is very interesting. The relation between the fires extinguished and held in check by the sprinklers remains practically the same in the wet and in dry system fires. The average pressures for each are the same in extinguished fires. In the held-in-check fires the average pressure for dry systems was four pounds above the average for each. The number of heads operating on the dry system, however, is sig-

nificant. More than twice as many operated on the dry system in the extinguished fires, and nearly twice as many in the held-in-check fires, as on the wet system. Among the wet systems the no claim fires amounted to thirty-eight per cent; the small loss fires comprised forty-five per cent and the large loss fires amounted to seventeen per cent of the total number. Among the dry systems, the no claim fires amounted to about twenty-nine per cent; the small loss fires to forty-three per cent; and the large loss fires comprised about twenty-nine per cent of the total number. In other words, the dry system fires resulted in fifty-nine per cent more large loss fires than did the wet system fires.

Of all the fires which occurred where sprinklers operated, thirty-seven per cent resulted in no claim for insurance indemnity; while in twenty-one per cent of the cases a large loss resulted. On the other hand, in the unsprinklered plants a large loss resulted in seventy-seven per cent of the cases, and some loss resulted in the remaining twenty-three per cent. The difference in the number of small or large losses where the sprinklers extinguished the fire or held it in check was negligible. The average amount of loss, however, both for small and large losses, was twice as much in the cases where the sprinklers held fire in check as it was in the fires that were extinguished by the sprinklers.

The average small loss from fires where the sprinklers operated was $484; the average large loss was $7,032; and the average for all fires where the sprinklers operated was $2,742. These averages do not include one large loss of $57,738. The average small loss from fires where there were no sprinklers was $1,014; the average large loss was $14,290; and the average for all fires occurring in unsprinklered properties was $10,307. The latter averages do not include one large loss of $325,000.

It is a significant fact that the four cases where over one hundred sprinklers operated, and the several cases where the loss was excessive under sprinkler protection, occurred in furniture and cabinet factories. This clearly indicates that the occupancy in the room was a factor in the large loss and excessive demands made on the sprinkler system. The moral is obvious—that combustible stock should not be kept or stored in close proximity to the dip tanks.

The average number of sprinklers in the rooms where dip tanks were located and fires occurred was eighty-five. The average number of heads opening was twenty-nine, or thirty-four per cent of those in the rooms. In eight cases the number of sprinklers in the room was sixteen or less, and in six of these practically all the heads operated. In three of these cases there was no claim, and the loss was small in four cases, with one large loss of $5,000. This seems clearly to show the desirability of shutting off the dip tank rooms. The ability of the sprinklers to successfully control dip tank fires would not seem to necessitate cutting off or isolating dip tanks from the rest of the property.

From the above summary of the fire record we feel warranted in stating that the dip tank fire hazard may be controlled and the losses from fire greatly reduced by the use of automatic sprinklers, and their success is

practically assured under the following conditions: Ample water supplies giving an average pressure of from fifty to seventy-five pounds; a well designed system and liberal pipe sizes; carefully distributed heads; a wet system; dip tank room shut off, but not necessarily cut off from room or property; and no storage of dipped stock or other inflammable material in dipping room. Automatic covers are very desirable and cut down the amount of water damage. The statistics do not seem to show either the necessity for, or undesirability of, overflow pipes where tanks are provided with automatic covers. Where the covers are lacking, the overflow pipes prove desirable.

The danger of fire can be largely eliminated by allowing only safety matches on the premises, none of any kind to be used in dip room; all open flame lights to be prohibited in room, and no electrical apparatus in rooms except double enclosed, keyless socket, incandescent electric bulbs with controlling switch located outside the room.

Dip Tank Hazard—Fire Record.

Total Number of Fires, 81.

1. CLASSIFICATION OF CAUSES.

Summary.

	No. of Fires.	Per Cent.
Matches	17	27.4
Intentionally ignited 11		
Accidentally ignited 6		
Smoking	5	8.1
Electric Sparks	9	14.5
Incandescent Bulbs 3		
Miscellaneous Apparatus 5		
Static Electricity 1		
Miscellaneous Sparks	10	16.1
Emery Wheel 3		
Forge 2		
From Miscellaneous Metals 3		
Live Sparks 2		
Open Flames	16	25.9
Lanterns 7		
Gas Flame and Burners 8		
Alcoline Lamp 1		
Burning Material	2	3.2
Hot Substances Plunged into Dip Tank	3	4.8
Total Known Causes	62	
Unknown or Cause not Reported	19	
Total	81	

Detail of Causes.

Matches 17

Intentionally ignited 11

Dipping pan contained twelve gallons of compound for armature coils. A workman lighted a match to see how the interior of an armature was coated. As soon as the match was lighted, the contents of the pan burst into a large flame.

Employee cleaning japan tank struck a match for light and ignited benzine vapors present.

Workman struck match on edge of dip tank containing a mixture of paint and twenty per cent naphtha.

Carelessness in use of matches while painting dip tank with asphaltum.

Workman lighted a match over asphaltum dip tank.

Employee cleaning up around dip tanks found a match and lighted it on tank. Tank contained nine barrels of turpentine varnish and this with several hundred chairs were ignited.

Lighted match dropped into small japan dip tank.

In lighting gas jet over dip tank, a lighted match was dropped into it. Tank contained about ten gallons of naphtha-thinned japan.

Head of match being lighted to start gas fires under drying oven flew and struck a paddle covered with japan, hanging over dip tank. Japan ignited and fire soon spread to tank.

Fire started in a small dip tank of about fifteen gallons capacity and partially burned draining rack and partition next to tank. Due to careless use of matches.

Boy lighted match and threw it at workman who was dipping sheet metal in a tank filled with a naptha-thinned paint.

Accidentally ignited 6

Matches stepped on near tanks 5

A sash which was being dipped fell and struck a match which ignited vapors..... 1

Smoking by employees while working about tanks 5

Electric Sparks 9

Incandescent Bulbs 3

Incandescent lamp was knocked from its support into dip tank. A series of explosions occurred in various dip tanks, followed by fire.

Japan in a small tank was ignited by an incandescent lamp which had been struck by a freshly dipped iron.

Employee dropped unprotected electric light on extension cord on floor near a benzine dip tank and ignited the vapors.

Miscellaneous Apparatus 5

Motor coil while in varnish tank was tested with electric current. Varnish immediately took fire.

Fire was started from spark from electric motor about eight feet from dip tank, igniting benzine vapors.

Spark from electric fan ignited naphtha vapors.

Electricians doing repair work caused spark while workmen were filling a benzine dip tank.

Fuse blew out on electrical circuit and ignited varnish in dip tank.

Static Electricity 1

A workman was about to dip a tray containing springs when fire flashed up from the japan tank, caused by spark either from frictional or static electricity.

Miscellaneous Sparks 10

Sparks from emery wheels ignited vapors..... 3

Sparks from forges ignited contents of tanks 2

Sparks from miscellaneous metals 3

While coils were being dipped in asphaltum benzine paint, metal saw was started which threw spark into zone impregnated with benzine vapors. There was a flash and entire building seemed afire.

Spark thrown from steam hammer ignited japan in small dip tank.

Fire caused by a spark from two unpainted castings thrown together upon drain pan of tank. Tank contained about 112 gallons of asphaltum paint, fifty per cent of which was naphtha.

Live Sparks 2

Sparks from foundry was blown through window and fell into dip tank.

Spark reached dip tank from fires twenty feet distant.

Open Flames 16

Lanterns 7

Watchman was dipping shovel in open tank containing varnish compound while using an ordinary lantern for light. An explosion occurred and dip tank was in flames.

Vapors from japan dip tank ignited from a lantern.

Watchman fell over dip tank, breaking his lantern and igniting the contents of dip tank.

Watchman raised cover of tank and was dipping a fish pole when vapors were ignited by his lantern.

Watchman's lantern ignited vapor from benzine filler in open dipping trough.

A pool of japan mixture had accumulated on floor near a leaky dip tank containing about sixty gallons of japan mixture thinned with naphtha. Vapor from mixture was ignited by watchman's lantern which in turn ignited the pool of japan on floor and in the tank.

Employee lowered lighted lantern into tank to ascertain quantity of varnish in tank. Lantern ignited vapors.

Gas Flames and Burners..... 8

Drippings from stock hung up to drain evidently dropped near gas flame and became ignited.

Employee was dipping wire frames in asphaltum thinned with naphtha. It is supposed that vapors from tank ignited from open gas lights.

Employee in lighting gas jet ignited dripping on his fingers and shook fire to drip trough of varnish tank.

Gas flame from oven apparently flared out when doors were opened and ignited benzine vapors from a 250-gallon tank about ten feet distant.

Steam was left turned on in japan tank, which caused vaporization. Benzine vapors drifted through open door to bluing machine which burned fuel oil. Vapor was ignited at this machine and fire flashed back to tank.

Vapors from tub of asphaltum near a lighted gas stove ignited.

Two dip tanks, six feet apart, with capacity of fifty or sixty gallons each, contained sterling varnish thinned with naphtha. Three armature coils which had been repaired were lowered into tank. Gas heated soldering furnaces were in use in room and vapors probably reached these, flashing back to tank.

Dipping tank contained about ten gallons of japan varnish and there was an open gas jet directly over the dipping table. Vapors probably ignited and flashed fire to tank and table.

Alcoline Lamp..... 1

Fire occurred in small galvanized can with open top used for japanning small iron parts. There was a hole in the side of this can and employee started to solder a patch over hole with an alcoline lamp. When he approached tank the naphtha vapors ignited. Fire rapidly spread through building.

Burning Material..... 2

Employee dropped a burning piece of paper into varnish dip tank.

A 250-gallon benzine-thinned japan dip tank located ten feet from gas heated baking oven took fire when employee lighted oven burners and threw taper near tank.

Hot Substances Plunged into Dip Tank..... 3

Workman plunged red hot iron into tank of benzine dipping black in order to warm it. Whole room was in flames instantly. Workman had barely time to escape.

Workman attempting to paint an eel spear, when red hot, by dipping same into asphaltum dip tank. Tank ignited, damaging roof and stock.

Pipe was heated in a coke fire and then dipped into asphaltum thinned with benzine. This material was ignited by a length of pipe which was too hot.

Unknown or Cause Not Reported.....19

Fire started in one of four adjacent dip tanks used for dipping plow shares and quickly spread to the other three, also to the roof, scorching the planking and cracking the glass in the roof. Lacquer in barrels was ignited and the tanks were damaged.

Metal laths dipped in compound containing large per cent of naphtha. This ignited from some unknown cause. Tank exploded, spreading fire throughout that portion of the building.

Fire was first seen at dip tank. On account of inflammable material in paint house, fire spread rapidly and exposed adjacent building.

Dip tank containing asphaltum mixture became ignited from unknown cause. Visitors nearby were said to have been smoking.

Fire started in dipping tank containing asphaltum thinned with benzine.

Man dipping metal parts in tank of asphaltum had lifted these out when fire flashed from among them and ignited the dip tank. Dip tanks contained about twenty-five gallons each of asphaltum thinned with a reducer paint. The composition of this was unknown, but it was volatile and highly inflammable and probably contained naphtha.

Fire occurred at night at dip tanks. May have been spontaneous ignition.

Fire occurred in dip tank containing varnish, benzine and turpentine.

Flash fire occurred at dip tank containing about 100 gallons of naphtha-thinned filler.

Fire originated at a dip tank containing 200 gallons of benzine mixed stain which instantly exploded. Fire then spread to five other dip tanks.

Japan room contained four dip tanks of considerable size not protected by automatic covers but having removable metal covers. Room also contained ovens heated by hard coal fires. After closing, the building was blown up by an explosion, exact cause of which was not determined.

Fire occurred in a small dip tank containing about eight gallons of benzine-thinned paint.

Fire occurred at dipping tanks, no further data..... 7

2. ANALYSIS OF LOSSES.

Losses as Compared to Sprinklered and Unsprinklered.

	Sprinklered.		Unsprinklered.		Total.	
	No. of Fires.	Per Cent of Sprinklered.	No. of Fires.	Per Cent of Unsprinklered.	No. of Fires.	Per Cent of Total.
No Claim	21	38.0	..	..	21	26.0
Small	23	42.0	6	23.0	29	36.0
Large	11	20.0	20	77.0	31	38.0
Total	55		26		81	

Relation Between Effect of Sprinklers and Losses.

	Extinguished.		Held in Check.		No Heads Opened.		Total Where Sprinklers Operated.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
No Claim	10	39.0	9	35.0	2	67.0	19	37.0
Small	11	42.0	11	42.0	1	33.0	22	42.0
Large	5	19.0	6	23.0	..	...	11	21.0
Total	26		26		3		52	

Average Sprinklered Losses.

	Extinguished.	Held in Check.	All Fires.
Small Loss Average	$351	$604	$484
Maximum	1,000	1,500	1,500
Minimum	56	200	56
Large Loss Average	4,113*	8,978	7,032*
Maximum	5,000	22,791	22,791
Minimum	2,156	3,094	2,156
Total Average	1,508*	3,744	2,742*

* NOTE.—One large loss of $57,738 not included. With this included the large loss average for extinguished fires is $14,838, and the large loss average for all fires is $11,642; the total average for extinguished fires is $5,525, and the total average sprinkler loss for all fires is $4,575.

Average Unsprinklered Losses.

Small Loss Average	$1,014	Large Loss Average†	$14,290
Maximum	1,500	Maximum	50,000
Minimum	75	Minimum	2,000

Total Average† $10,307

† NOTE.—One large loss of $325,000 not included. With this included the large loss average for unsprinklered fires is $35,004, and the total average unsprinklered loss is $25,292.

No Sprinklers Opened.

No claim. Fire allowed to burn itself out.

No claim. Fire smothered by metal cover of tank.

Loss of $408. Extinguished in fifteen minutes by wet blankets, sand and two hose streams.

SPRINKLER FIRE RECORD.

3. EFFECT OF SPRINKLERS.

	No. of Fires.	Per Cent of Whole.
Extinguished or practically extinguished fire	26	50
Held fire in check	26	50
Unsatisfactory	..	..
Total	52	
No sprinklers operated	3	
Total	55	
No Claim	19	37
Small Loss	22	42
Large Loss	11	21
Total	52	
No sprinklers operated	3	
Total	55	

4. NUMBER OF SPRINKLERS OPENED.

No. of Sprinklers Operating.	Extinguished Fire. No. of Fires.	Extinguished Fire. Per Cent.	Held Fire in Check. No. of Fires.	Held Fire in Check. Per Cent.	Unsatisfactory. No. of Fires.	Total. No. of Fires.	Total. Per Cent.	No. of Sprinklers Operating.	No. of Fires.	Per Cent of Whole.
1	3	11.5	2	7.7	..	5	9.6	1	5	9.6
2	2	7.7	2	7.7	..	4	7.7	2 or less	9	17.3
3	4	15.4	..	..	..	4	7.7	3 or less	13	25.0
4	..	..	1	3.8	..	1	1.9	4 or less	14	26.9
5	2	7.7	2	7.7	..	4	7.7	5 or less	18	34.6
6 to 9 inc.	8	30.8	2	7.7	..	10	19.3	Less than 10	28	53.9
10 to 24 inc.	1	3.9	8	30.8	..	9	17.3	Less than 25	37	71.2
25 to 49 inc.	3	11.5	4	15.4	..	7	13.4	Less than 50	44	84.6
50 and over	3	11.5	5	19.2	..	8	15.4	50 and over	8	15.4
Total....	26		26			52				

Average number of sprinklers opened, not including unsatisfactory, 28.7.
Excluding 4 cases where more than 100 heads opened, 17.3.

Per Cent of Sprinklers in Room :—

All the sprinklers in room opened in 17 per cent of the cases.

More than half of the sprinklers in room opened in 31 per cent of the cases.

About one fourth of the sprinklers in room opened in 52 per cent of the cases.

An average of 30 per cent of the sprinklers in the rooms opened for all cases.

5. DETAILS OF LARGE LOSS SPRINKLER FIRES OR WHERE A LARGE NUMBER OF HEADS OPENED.

6096. Furniture Factory. Fire occurred on third floor of frame building, lath and plaster ceiling, under joist and spread to dip tank containing 200 gallons of benzine stain. Quick flash fire resulted, which spread to other dip tanks, five in all. This made a very quick-spreading hot fire, which got into concealed space under roof, and 198 sprinklers in all opened. Sprinklers practically controlled and extinguished fire except in concealed space. Fire was finally extinguished with the aid of hose streams. Factory was equipped with Grinnell glass disc sprinklers, two dry systems, standard spacing and arrangement, supplied by waterworks at eighty pounds and gravity tank. Water supplies seem to have been adequate.

The lesson to be learned was that dip tanks should have proper overflow pipes and automatic covers.

366. Furniture Factory. Factory had just been equipped with Neracher sprinklers. Two pressure tanks contained 6,000 gallons of water and were acting temporarily as a gravity supply giving a pressure of twenty pounds where fire occurred. Fire was caused by a man who found a match and lighted it to see if it was a good one. All the sprinklers in room, 135, operated, and practically extinguished the fire. A loss of $4,476 resulted.

The work done by the sprinklers in this fire was remarkable for the following reasons :—

First, at the time of the fire the system in this section was shut off, although the last sprinkler had just been installed by the sprinkler men. As soon as the sprinkler foreman heard the cry of fire, he ran to the basement and turned on the water, requiring about two minutes.

Second, the fire pump was inoperative, as new connections were being made. The two pressure tanks located fifty feet above the fire exerted only a gravity pressure, as the air had not been pumped up.

Third, the fire communicated to a room full of freshly varnished chairs and a tank containing about nine barrels of turpentine varnish. The chairs were all badly burned and most all woodwork in the room was badly charred.

Fourth, the fire department was late (about twenty minutes) in getting a stream on the fire and found it necessary to extinguish only a few small flames under small benches. The water in tanks was exhausted when fire department took control.

The spread of the fire was so rapid that some of the workmen were obliged to jump from the second-story windows. The foreman of department watched the fire through an opening in the fire doors and stated that the first rush of water seemed to blanket the fire and to hold it down and extinguish it.

1747. Metal Worker. Manufacturing Looms. This building was three stories in height, of wood, mill construction except the roof; first story being occupied for painting and finishing; second story for finishing and loom harnesses; and the third story for finished stock.

Sprinkler equipment was rather old. The heads consisted of Grinnell, Esty and Fowler, supplied by city waterworks which gave a static pressure of forty pounds on the sprinklers that first operated.

The alarm was rung in and department promptly responded. In the meantime, the sprinklers on that floor were doing their duty, heads opening to the number of twenty-seven. On the arrival of the firemen, someone in authority in the fire department ordered the sprinkler valve for that section shut off. The firemen supposed the fire was out, but it was soon discovered issuing through the roof of building. This room was filled with finished stock, mostly of wood dimension stuff and finished material ready for assembling in loom work. It seemed that the fire had broken out through the window, unnoticed, and leaped up along the outside of the building into the jet of the roof, working its way into the storage room on the third floor, skipping the second floor, in which there was little damage. The sprinklers were immediately turned on again and the firemen tackled the fire through the roof. Before the fire was out eighty-three heads had opened. Loss $12,000.

3940. Woodworker. Fire occurred in a dip tank located in the varnish room. There were 168 Neracher sprinklers in room supplied by city water which gave a static pressure of twenty-one pounds on the heads that operated. There were four other dip tanks in room, three of which took fire. These were overflowed by water from the sprinklers and flames were rapidly spread about. There were 108 sprinklers which operated and held the fire in check. A loss of $22,791 resulted.

4904. Furniture Factory. A watchman took his lantern into the varnish room and ignited the dip tank. There were 219 International sprinklers in room, all of which operated. They were on a dry system containing 625 heads. The action of the heads was apparently slow due to this fact, and they could not at first cope with the rapid hot fire which ensued. The supply consisted of pressure tank giving a pressure of eighty pounds. A loss of $8,983 resulted.

6. POINTS OF INTEREST FROM FIRE REPORTS.

11044. Fire burned fiercely until the contents of a twelve-gallon dipping pan were consumed.

9858. Sprinklers overflowed a tank of burning naphtha-thinned paint. Sand dams were built and fire allowed to gradually burn itself out.

366. Sprinkler system had just been installed, but water had not been turned on. When fire occurred valve was opened and water in pressure tanks flowed out. This was a hot flash fire, but when water was turned on, the first rush seemed to extinguish it.

13694. Fire occurred in dip tank containing 300 gallons of japan. The sprinklers played a very important part in checking the fire and preventing it from doing any serious damage.

U-2276. Automatic covers on dip tanks worked successfully, but overflows were not carried into pits and fire flashed back through these.

1889. Sprinklers extinguished this fire just as the tank was on the verge of overflowing.

8192. Cover was promptly put on tank of burning japan, but fire was not extinguished until fire department operated chemicals and hose streams.

5884. Forty-nine sprinklers opened on two floors, and did excellent work in controlling this severe fire in 112-gallon dip tank of asphaltum paint containing fifty per cent naphtha.

255. The water from the hose and sprinklers overflowed the japan tanks, and the burning japan floated on top of the water, running down the walls to floor below, where it was extinguished with brooms.

12062. Automatic cover closed properly. Sprinklers operated and entirely extinguished the fire.

11235. Water from sprinklers did not extinguish fire in tank, but cooled it down to such a degree that employees were able to cover tank with burlap bags, etc., which finally extinguished the fire. However, the sprinklers protected the nearby combustible material.

6096. Sprinklers practically controlled and extinguished fire except in concealed space under roof.

U-6281. Fire occurred in an unsprinklered, reinforced concrete building constructed on the Kahn system. The entire combustible contents were destroyed and roof totally collapsed. Three men were badly burned and one was fatally injured.

7041. This fire showed the danger of using ordinary parlor matches where benzine is used. It also showed the advantage and necessity of having sand or chemical extinguishers in a paint or japan fire. It is probable that without the chemical extinguishers, sprinkler discharge would have overflowed dip tank and spread fire to various parts of the building.

7. SECONDARY SUPPLIES.

To Sprinkler Systems.

2061. Primary supply was automatic pump giving sixty pounds pressure on sprinklers that operated. Steamer connection used, giving eighty pounds. Fire held in check.

3940. Primary supply was waterworks giving twenty-one pounds pressure on sprinklers that operated. A 750-gallon steam pump was used, giving eighty pounds. Fire held in check.

4914. Primary supply was waterworks giving fifty-eight pounds pressure on sprinklers that operated. Steam pump used, giving eighty pounds. Fire held in check.

5689. Primary supply was waterworks giving forty-five pounds pressure on sprinklers that operated. Steam fire pump was used. Fire held in check.

6096. Primary supply was waterworks giving eighty pounds pressure on sprinklers that operated. Gravity tank was used. Fire held in check.

370. Primary supply was pressure tank giving forty pounds pressure on sprinklers that operated. Pump in basement was used. Fire practically extinguished.

702. Primary supply was gravity tank giving twenty-five pounds pressure on sprinklers that operated. A 500-gallon pump was used. Fire practically extinguished.

1889. Primary supply was automatic pump giving fifty pounds pressure on sprinklers that operated. City waterworks was used. Fire completely extinguished.

10073. Primary supply was waterworks giving fifty pounds pressure on sprinklers that operated. A gravity tank was used. Fire entirely extinguished.

NOTE.—In no case was the secondary supply apparently of any essential factor in the successful sprinkler control which resulted in these cases.

Other Agencies Used for Extinguishing Fires Where Sprinklers Held Fire in Check.

Fire department alone, seven cases.
One hose stream and pails of sand.
Hose streams and chemical extinguishers.
Fire smothered, two cases.
Chemical extinguishers.
Standpipe hose and dry powder used.
Chemicals and hose streams.
Hose streams and brooms.
Twenty-four chemicals, hand hose and fire department.
Burlap bags.
Sand pails, chemical extinguishers and hand hose.
Private yard hose streams.
Chemicals, pails and fire department.
Yard hose streams and fire department.
Use of ashes.
No data, four cases.

8. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Waterworks,	34	68	68	25	32	36	..	76	61	..	26	24
Gravity tank,	8	16	20	35	8	8	..	28	7	..	39	32
Pressure tank,	5	10	79	48	6	4	..	78	40	..	4	114
Automatic pump,	3	6	53	34	4	2	..	50	30	..	19	64
Total,	50	100	61	30	50	50	..	66	55	..	25	34

9. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	1	2	5	1	..	2	..	..	5	..	..	1
15 to 24 inclusive,	6	12	19	62	4	8	..	21	18	..	68	59
25 to 49 inclusive,	7	14	37	16	8	6	..	33	42	..	17	15
50 and over,	36	72	76	28	38	34	..	78	69	..	22	34
Total,	50	100	61	30	50	50	..	66	55	..	25	34

10. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	29	58	59	21	30	28	..	66	52	..	17	25
Dry system,	21	42	62	42	20	22	..	66	59	..	38	46
Total,	50	100	61	30	50	50	..	66	55	..	25	34

11. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS —As Regards Amount of Loss.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Waterworks,	34	68	68	25	24	32	12	66	68	71	10	16	80
Gravity tank,	8	16	20	35	4	6	6	23	23	17	3	13	79
Pressure tank,	5	10	79	48	2	6	2	100	72	80	2	6	219
Automatic pump,	3	6	53	34	14	..	2	50	..	38	19	..	64
Total,	50	100	61	30	34	44	22	61	62	56	10	14	91

12. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS —As Regards Amount of Loss.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Less than 15 lbs.,	1	2	5	1	2	..	..	5	..	..	1	..	..
15 to 24 inclusive,	6	12	19	62	..	4	8	..	22	18	..	13	86
25 to 49 inclusive,	7	14	37	16	2	12	..	40	36	..	5	18	..
50 and over,	36	72	76	28	30	28	14	66	79	78	11	13	93
Total,	50	100	61	30	34	44	22	61	62	56	10	14	91

13. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS. —As Regards Amount of Loss.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Wet system,	29	58	59	21	22	26	10	64	63	37	13	8	72
Dry system,	21	42	62	42	12	18	12	56	60	73	5	24	107
Total,	50	100	61	30	34	44	22	61	62	56	10	14	91

Gas Plants—Fire Record

Total Number of Fires, 53.

1. CLASSIFICATION OF CAUSES.

Summary

Common Causes.

	No. of Fires.	Per Cent of Common Causes.	Per Cent of Known Causes.
Heating	3	25.0	7.5
Lighting	1	8.3	2.5
Power	2	16.6	5.0
Smoking	1	8.3	2.5
Matches	1	8.3	2.5
Oily Material	1	8.3	2.5
Sparks	2	16.6	5.0
Boiler Explosion	1	8.3	2.5
Total	12		

Special Hazard Causes.

	No. of Fires.	Per Cent of Special Hazards.	Per Cent of Known Causes.
Gas leakage	7	28.0	17.5
Purifying process	6	24.0	15.0
Tar accumulations	2	8.0	5.0
Spontaneous ignition of coal	2	8.0	5.0
Producer gas generator	1	4.0	2.5
Testing	1	4.0	2.5
Superheating	1	4.0	2.5
Distilling tar	1	4.0	2.5
Miscellaneous	4	16.0	10.0
Total	25		
Common Causes	12		30.0
Special Hazard Causes	25		62.5
Incendiary	2		5.0
Exposure	1		2.5
Total Known Causes	40		
Unknown Causes	13		
Total	53		

Details.

Common Hazards.

6141. Heating. Wind blew down metal chimney of small coke stove and tipped over the stove, which ignited woodwork of building.

369. Lighting. Employee took lantern into basement to look for leak in main, which ignited the gas.

6359. Lighting. Explosion caused by turning on incandescent electric light in room full of escaping gas.

2263. Lighting. Workman entered gas house with lighted lantern, and escaping gas ignited.

5859. Power. Car couplings, iron bars, etc., were probably carried into machinery, resulting in stopping and short circuiting motors. In absence of local fuses thinnest part of feed wire heated, igniting woodwork.

3372. Gasolene Explosion. Employee was drawing gasolene to start gasolene engine when same exploded.

8098. Smoking. Lighted pipe left in employee's overalls.

2641. Gas Explosion. Gas in main building ignited by a match, and an explosion resulted.

4850. Oily Material. Oily waste in hoisting-towers.

1788. Sparks. Sparks from smokestack on roof.

2807. Locomotive Sparks. Sparks from shifting engine in yard.

4548. Boiler Explosion.

Special Hazards.

2928. Drawing Gas. Rupture of crown of large gas holder allowed gas to escape which ignited from an open flame.

3428. Leaking Gas. A defective valve in basement allowed gas to escape and come in contact with open lights.

5385. Gas Leakage. A leakage of gas occurred and the volume of gas flowed into an adjoining building to an open gas light.

4629. Gas Explosion. Leaking gas ignited by fires in bench house.

1715. Gas Explosion. Leak in pipe of Lowe system water gas allowed same to come in contact with boiler fire. An explosion occurred, but no fire resulted.

2452. Gas Explosion. Explosion of gas which destroyed the gasometer. Accumulation of gas and air which had collected by reason of a leak between the tank walls and roof of building, thought to have been ignited by defective electric light wiring.

2696. Leak in Main. Workman was calking a twelve-inch main in valve house. An air-inflated rubber bag had been inserted in the main to shut off the gas according to custom. Probably a spark from workman's tool ignited leaky gas, which burned out the rubber bag, leaving entire twelve-inch gas main open to flame.

7748. Iron Filings. Overheating of a large pile of iron filings.

8458. Purifier. Spontaneous ignition of iron filings and sawdust when purifying box was opened.

S-13721. Purifier Box. Gas was liberated by the blowing out of a water seal on one purifier box and probably ignited by a spark from a locomotive.

5349. Purifier. Explosion of purifier. Five persons injured.

4832. Purifier. Unknown in purifying box. Workmen had just changed one of purifying boxes and put in fresh material, when something blew up.

3134. Purifier. Purifying box was sealed with water, which had become low and allowed gas to escape. An employee, who discovered leak, went into purifying house and endeavored to find the electric switch, which, however, was outside. He struck a match, which caused an explosion.

2334. Ignition of Tar. Tar in retort house was ignited by flames and communicated to wooden coal conveyor.

995. Gasometer. Not known, but possibly spark in tar accumulation in gasometer.

5455. Charcoal Screenings. Spontaneous ignition in pile of charcoal screenings.

348. Soft Coal. Spontaneous ignition of soft coal.

5715. Producer Gas Generator. Hot coals from producer gas generator dropped through floor on some tar, which set fire to wooden floor.

8442. Testing. Bunsen burner used to heat test oven caught fire in air chamber, burning off rubber connection and ignited gas.

1731. Superheater. Back pressure of the superheater.

5322. Tar Still. A leaking pipe allowed tar to reach furnaces under stills, causing fire.

1504. Catch Pit for Waste Oils. Hot cinders were placed on cover of pit to catch basin.

4353. Gas Machine. Gas machine operator failed to operate the right valve and allowed gas to escape into the engine room, which was lighted by open gas jets.

1847. Retort. Coal from retort.

1868. Furnace Chimney. Chimney from furnace set fire to roof.

2. LOSS STATISTICS.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
None	..	..	3	14	..	..	3	7.0
Small	3	43	6	27	6	50	15	37.0
Large	4	57	9	41	4	33	17	41.5
Total Loss	..	..	4	18	2	17	6	14.5
Total with data given,	7		22		12		41	
No data	5		3		4		12	
Total	12		25		16		53	

3. ROOMS IN WHICH FIRE OCCURRED.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Storage	1	9.1	1	4.2	6	37.5	8	15.7
Purifying House	1	9.1	5	20.8	1	6.3	7	13.7
Gas House	2	18.1	2	8.3	1	6.3	5	9.8
Retort House	..	..	2	8.3	3	18.7	5	9.8
Meter Room	1	9.1	..	..	2	12.5	3	5.9
Coal or Coke Storage,	..	..	2	8.3	1	6.3	3	5.9
Basement	1	9.1	1	4.2	1	6.3	3	5.9
Engine Room	2	18.1	1	4.2	..	..	3	5.9
Gasometer	..	..	2	8.3	..	..	2	3.9
Boiler Room	1	9.1	1	4.2	..	..	2	3.9
Still Room	..	..	2	8.3	..	..	2	3.9
Roof	1	9.1	1	4.2	..	..	2	3.9
Valve House	..	..	1	4.2	..	..	1	2.0
Cupola Room	..	..	1	4.2	..	..	1	2.0
Test Room	..	..	1	4.2	..	..	1	2.0
Locomotive House	1	9.1	..	..	..	..	1	2.0
Miscellaneous	..	..	1	4.2	1	6.3	2	3.9
Total with data given,	11		24		16		51	
No data	1		1		..		2	
Totals	12		25		16		53	

4. DAY OR NIGHT FIRES. (Day Fires 6 a. m. to 6 p. m.)

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Day	5	45.5	15	60.	5	38.5	25	51
Night	6	54.5	10	40.	8	61.5	24	49
Total with data given,	11		25		13		49	
No data	1		..		3		4	
Total	12		25		16		53	

5. PLANT IN OPERATION.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Plant in operation .	9	90	24	100	9	64	42	88
Plant not in operation	1	10	..	..	5	36	6	12
Total with data given,	10		24		14		48	
No data	2		1		2		5	
Total . . .	12		25		16		53	

6. HOW DISCOVERED.

	Common Causes.		Special Hazards.		Unknown Incendiary Exposure.		Total No. of Fires.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Employee . . .	5	50	18	82	7	50	30	65.0
Watchman . . .	2	20	2	9	1	7	5	11.0
Outsider	2	20	..	..	6	43	8	17.5
Explosion . . .	1	10	2	9	..	..	3	6.5
Total with data given,	10		22		14		46	
No data	2		3		2		7	
Total . . .	12		25		16		53	

7. FIRES OF INTEREST.

H-4353. This fire was caused by the mistake of a gas machine operator who, by failing to operate the right valve at the right time, allowed gas to escape into the engine room which was lighted by open gas jets.

This part of the plant was of brick construction, twenty-six feet by eighty feet, slate roof on boards and wood truss. Brick floor in engine room; wooden floor with basement under and wood ceiling in station meter room. These rooms were located between the purifier and the generator rooms from which they were separated by twelve-inch brick walls.

Gas was manufactured by the water gas process. It was at the beginning of a "down" run that the mistake occurred. The operator had closed the stack, opened the oil valve, and instead of closing the air blast valve which cuts off the supply of air from the engine room, he admitted steam at the top of the generator. This immediately produced a higher pressure in the generator than that of the air blast. The gas was thus forced out through the air blast pipe and through the blower into the engine room, where, coming into contact with an open lighted gas jet, it burst into flame. Had the operator at this point shut off the air valve the damage would have been slight, but he became excited and did not know what to do; mean-

time the escaping gas was feeding the flames until another employee, who understood the machine, closed the proper valves. By this time the roof and truss had caught fire. An attempt was then made to use the hose, 150 feet of which was kept in the engine room (but which was not connected to the standpipe located in the generator room), when it was found that the hose had been destroyed by the intense heat. An alarm was sent in from public box two blocks from plant, but at the time the alarm sounded the fire department were returning from a down town fire and were two miles away. About ten minutes elapsed after alarm sounded before they arrived, or about twenty-five minutes after the fire started. By that time the roof was a mass of flames. Fire was under control in about an hour and was confined to engine and meter rooms.

S-13721. As this plant had to be shut down for a boiler inspection, it was being run until ten or eleven o'clock at night to accumulate a sufficient supply of gas to allow for the usual consumption on the day when the plant was to be idle. Under these conditions the pump forcing gas through the purifiers was probably run too fast and the excess pressure thus accumulated blew out the water seal and allowed gas to be liberated into the purifier building. This was a small two-story brick building with joist roof and floor, cut off from the generating building by a blank brick wall. Adjoining this purifier building was a small frame one-story shed used for a machine shop. The foreman, going into the purifier building from the machine shop, discovered that one of the water seals had blown out and that gas was escaping. He immediately rushed to the controlling valves to shut them, leaving the door from the purifier building to the machine shop open, thus allowing gas to fill that building also. Just as he started to shut the valve the gas in the purifier building exploded, blowing off the roof, and immediately afterwards another explosion occurred in the machine shop which was totally destroyed. The foreman stated that immediately before the explosion a locomotive passed and a spark from this is the only cause of ignition of the gases that could be given.

Very little fire ensued after the explosion, due without doubt to the fact that the valve had been closed. A little waste, rags, etc., caught fire, but were extinguished by a stream laid by the fire department who responded to an alarm pulled by an outsider.

Loss was estimated at $300.

H-4629. The municipal gas works of the city of Hamburg, Germany, are located a short distance outside the city at a place called "Kleines Grasbrook" on the banks of the River Elbe. The apparatus is of the most modern character, and the city expended $3,500,000 for the construction of a colossal gas tank of 2,354,400 cubic feet capacity, the largest in the world. A leak in this tank, which was partly filled, caused a catastrophe on December 7, 1909, the leaking gas being ignited by the fires in the bench house. About twenty men were working about the tank and vanished in the column of flame that shot high in the air when it exploded. Forty others were badly burned and injured. Fire followed the explosion, but the heat was so intense that the firemen could only direct their efforts

towards the protection of the rest of the plant, and in spite of their hard work a second explosion resulting in the destruction of the old tank of about 575,000 cubic feet capacity occurred. The catastrophe seriously crippled the city's lighting facilities as far as gas was employed.

H-1504. The top of a catch basin pit for oils, grease, tar, etc., was covered by two-inch planks on joist with trapped openings. On the day of fire, all openings were closed. A workman wheeled hot cinders from boiler house and dumped them on the wooden cover over pit. In the pit the gas heated by steam, and in composition with the oils and other waste from the plant, was in the proper condition to be ignited. Red hot cinders dropped through the cracks in cover or burned through the wood. The workman who was on top of the cover was blown about twenty feet into the air and instantly killed.

H-2928. During the drawing of gas from one of the large holders, the holder was interrupted suddenly on its lowering, causing a cushioning of the gas against the crown of the holder, rupturing the rivetted seams and making a large opening, allowing the escape of all the gas. The ruptured holder was one of three situated close together, each having the capacity of 2,800,000 feet, measuring 134 feet in diameter and 60 feet high.

The gas or vapor was what is termed "oil gas," used for enriching. It was a product of petroleum. Being heavier than coal or water gas it descended and was carried by the wind along the ground over an open field. A few seconds after its escape the heavy volume of the gaseous mixture covering a space 800 feet long and about 300 feet wide became ignited by a flash. In the path of the flame were three buildings, one a meter house of the gas company, another a clubhouse, and another a vacant dwelling which was fitted up for an employee of the gas company. The vapor entered these buildings and the resulting ignition damaged two of them considerably. The damage of the meter house was mainly due to explosion. Several of the employees of the company were caught in the vapor and before they could escape they were burned to death. The flash lasted only a few seconds, but the gaseous mixture was very hot, even setting fire to the grass on the ground.

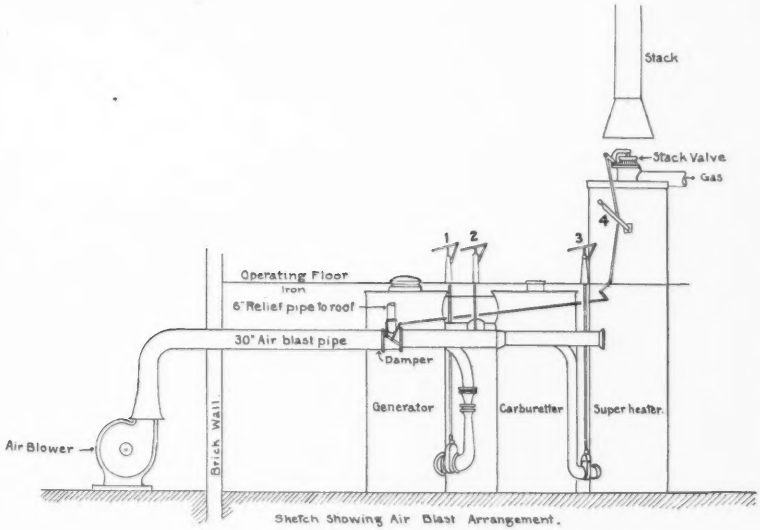
The holder was of the telescope pattern, being in three sections, and had been used for six years. The lower section and upper one were in proper position, but the middle one projected about three feet above the level of the pit, showing that it had been obstructed in its way down. It was supposed that the vapor was ignited by either the fire pot of a plumber who was working in the dwelling house, or from a gas flame in use to heat water in the clubhouse.

H-8602. This fire was caused in the blower room of the generator building by an explosion of gas which leaked back into the blower room through defective valves and was ignited by the heat in the generator when the valves were opened. The fire was discovered by an employee who was in the building and who pulled the public fire alarm box in the yard. The fire was practically extinguished by a chemical and one private hose stream by the time the public department arrived. The explosion blew out all

windows and doors in the blower room and part of those in the building and also the windows on the north end of the boiler house. Some of the woodwork in the blower room was ignited but was quickly extinguished.

The cause of the explosion was as follows: On the accompanying sketch showing air blast arrangement, valve No. 1 admits air to the generator, No. 2 to the carburetor and No. 3 to the superheater. These are simply quick closing valves operated from the operating floor. No. 4 is a lever for operating the stack valve and at the same time operating the damper in the air blast pipe. During the blow, or the period of heating the apparatus, the stack valve is open and consequently the danger valve also, as the blower is run during this period and air is admitted to the generator, carburetor and superheater to aid combustion. At this time the damper in the six-inch relief pipe is shut. During the run the stack valve, and therefore the damper, are shut, and also valves Nos. 1, 2 and 3. The damper in the relief pipe is open at this time to allow any gases that leak through the valves Nos. 1, 2 and 3 to escape.

In the case of this explosion the collar on the spindle of the damper slipped, and when the stack valve was closed the damper failed to shut and the relief failed to open. Large quantities of gas must have leaked by the manually operated valves, or else one was left partially open accidentally. The gas was thus allowed to enter the blower room through the blast pipe, and when the manual valves were opened fully the heat ignited the gas in the blast pipe and it flashed back into the blower room and caused the explosion. A loss of $300 resulted.



Sketch Showing Air Blast Arrangement.

H-8602.

GENERAL FIRE RECORD.

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers.

Where sprinklers fail the cause is, almost invariably, clear. These fires are selected to indicate such causes, that they may be generally understood and satisfactorily met.

S—13940. Wholesale Grocery. This plant had recently been bought by present owners and it was being remodeled for their occupancy. One of the former open elevator shafts provided with automatic traps was replaced by a brick stair and elevator shaft; the other open elevator shaft was to be closed, but at time of fire was in original condition. The owner was making numerous changes throughout; among others was the installing of a fire resistive area on the 5th floor at the east wall. This area was cut off by brick wall; the former floor was substituted by reinforced concrete floor. This area was to be occupied for coffee roasting and grinding. It would seem from information obtained that the fire originated at or near this area, and it spread with great rapidity. It became necessary at different times in different parts of the building, on account of remodeling, to close valves attached to the sprinkler equipment, but in the installation of the coffee roasting area it was found necessary to take down sprinkler piping, and it would appear that instead of plugging lines this one system supplying upper and east portion of building was shut off. The failure of automatic sprinklers to control fire was attributed to this condition. Nothing remained of the building except a small portion of the walls, which had to be torn down. At the north there were several 5 and 6 story brick sprinklered buildings detached across public alley 20 and 27 feet. All window openings facing fire were protected by standard metal frames with wired glass, and this protection alone saved these several buildings from severe loss.

This fire demonstrates the necessity for great care when any portion of the sprinkler system must be disconnected. Only the smallest possible portion of the equipment should be disconnected at one time, and pipes plugged in such a manner that no larger portion of plant than is absolutely necessary will remain without sprinkler protection.

Miscellaneous Fires.

Interesting fires are given under this heading without regard to their classification.

S-14091. Celluloid Manufacturing. Scrap Cutting Building. This was a one-story fireproof building forty by sixty feet in area with twelve-inch brick walls, concrete floor and reinforced concrete roof. All windows in the building were wired glass in hollow metal frames or steel frames, and the building was divided into three sections by brick walls and three-ply standard automatic closing fire doors. Scrap cutting, washing and drying were carried on in this building. The scrap cutting room was cut off from the wash room by a twelve-inch wall, with one opening provided with a standard tin-clad automatic sliding fire door, and two small openings through which the scrap was pushed into the scrap cutting room, which were provided with two-ply tin-clad hanging fire doors. These doors could not be kept open except by holding them with the hand. There was a three-ply tin-clad swinging non-automatic fire door from the scrap cutting room into the yard.

Building was equipped with International automatic sprinklers installed in 1911, supplied by a six-inch connection from ten-inch private main, and sprinklers were controlled by a post indicator valve. Spacing was standard except in one instance there were three heads on a three-fourths inch pipe, as follows: one head at ceiling, one over bench where scrap came through wall, and one in cutting machine. There was an alarm valve with outside water motor gong.

Scrap Sorting Building. This was a one-story brick building, area thirty-seven by eighty feet. Walls were twelve-inch brick, parapeted above the roof, and all windows were wired glass and metal frames. Building had a concrete floor; one-inch board roof covered with slag on joists. The ceilings were wood sheathed. The building was divided into two equal sections by a twelve-inch brick wall parapeted above the roof with one opening protected by a three-ply tin-clad automatic sliding fire door.

Building was equipped with International automatic sprinklers installed in 1911, supplied by a six-inch connection from ten-inch private main, and sprinklers were controlled by a post indicator valve. Spacing was standard. There was an alarm valve with outside water motor gong.

Scrap Storage Buildings. There were six buildings, each ten by forty feet in area, and two buildings each twenty by twenty-five feet in area. These buildings were separated from each other by twelve-inch blank brick walls, parapeted above the roof. The buildings had concrete floors and the roofs were one-inch boards on joist, covered with slag; ceilings wood sheathed.

These buildings were equipped throughout with Grinnell automatic sprinklers installed in 1911 by the owners. They were supplied by four-inch underground connections through a four-inch Grinnell dry valve located in the basement of the scrap cutting and washing building. The dry valve had a six-inch connection from ten-inch private main.

The scrap cutting building, scrap sorting building and the scrap storage buildings are separated from each other approximately sixty to sixty-five feet.

The water pressure at this plant was 100 pounds. At the power house there was a six-inch connection from a sixteen-inch city high pressure main tied into ten-inch private mains. The pressure was reduced from 135 to 100 pounds.

Story of the Fire. The fire started in the scrap cutting room at 7.16 p. m. Plant was running overtime in this section when the fire occurred. The fire was caused by some foreign material striking a spark in one of the rotary scrap cutting machines. As soon as the fire occurred the men in the scrap cutting room ran into the yard, leaving the door from this room into the yard open. There was a large amount of scrap stock stored in boxes, crates and barrels throughout the yard, between this building, the scrap storage building and the scrap sorting building.

The fire spread very rapidly throughout the yard and into each of the scrap storage buildings, although there were two-ply tin-clad swinging fire doors at each section of these buildings. These fire doors overlapped four inches on three sides but closed on the flat concrete floor at the bottom, there being no sill. The fire also extended through the yard to the scrap sorting building and probably entered this building in a similar manner as it entered the scrap storage building, that is, the fire entered under the fire door.

The fire was very severe in the scrap cutting room, opening all heads (6), and the heat was so intense that it opened all the heads (14) in the wash room and all the heads in the drying room with the exception of three and the four heads which were located inside of the dryer. All of the eighty-two sprinklers in the scrap storage buildings were opened. In the north section of the scrap sorting building twenty-one of the twenty-four heads in this section opened, but none of the twenty-four heads in the south section were fused.

The first alarm was at 7.16 p. m. from the private city fire alarm box located on the outside of the scrap sorting building; the second alarm was sent in shortly after the first. Eight engines and three trucks responded and sixteen streams were used on the fire; ten of these streams were from the city hydrants and six were from the private hydrants which were

supplied by the city high pressure service. The two hydrants in the yard were not used until approximately three-quarters of an hour later, due to the intense heat from the burning stock in the yard. The fire was declared to be out at 4.10 a. m.

The damage to the scrap cutting building, machinery and stock was trifling; the damage to the scrap sorting building was trifling to the building and machinery but considerable to the stock in the north section; the damage to the scrap storage buildings was considerable, all of the roofs being practically burned off, the fire doors badly burned and practically all of the contents was destroyed. The walls remained in good condition except that some of the tile coping was off in places. Total loss was $16,710.

Points of Interest. The rapidity with which the fire spread throughout the yard from the scrap cutting building to the scrap sorting and scrap storage buildings, sixty to sixty-five feet distant from the scrap cutting building where the fire started, was remarkable. Had the fire door opening into the yard been equipped with an automatic closing device it is believed that fire would have been confined to the room in which it originated, without further loss.

The steel frame windows installed in the north wall of the scrap storage buildings received practically no damage from the severe heat in these rooms, although the wired glass was melted out of most of the frames. There was a twelve-inch iron I-beam located in the center of each of the larger scrap storage buildings with a twenty-five-foot span. The girder was unprotected, and although the roof was burned off, these girders did not warp at all. This may be due to the fact that a line of sprinklers was located directly under the girder.

There were approximately 100,000 pounds of scrap celluloid stored in the scrap storage buildings and in the yard, and the heat developed from the burning of this scrap storage was terrific. The flames shot high into the air and the metal ventilators on the roof of the buildings were red hot at times.

A peculiar feature in the scrap sorting building was that the windows on the north wall, although of wired glass and metal frames, were badly burned. The glass was broken and in some cases it had melted and fallen out of the window frame, probably due to burning cases standing outside of building. Nevertheless the scrap celluloid stored within two feet of these windows inside of the building did not burn, and no sprinklers were opened in this section (south). The fire department may have been using hose streams on these windows from the inside of the building.

The sprinklers were of value in the scrap cutting, drying and washing buildings, and also held fire in check in the scrap sorting building.

H-8363. (See Frontispiece.)

Interior view showing destruction of wood flooring and trim, and broken soffit of floor arch.

H-8363. Gibson House Fire and Union Trust Building, Cincinnati, O., December 10, 1912. The Gibson House was a transient hotel, with shoe store, barber shop and offices using part of first story. It was a six-story brick and stone building of ordinary construction. There were three brick divisions to roof with unprotected openings. Floor openings were

H-8363.

Office of architect on eighteenth floor. Note destruction of woodwork and collapse of tile insulation of steel members and tile partitions.

unprotected. Rear part of building had been torn down and work started on a new building. A temporary rear frame wall covered with tar paper had been erected. The excavation for the new building was entirely covered with a wood platform. Fire started under this platform, presumably from salamanders left by workmen.

The Union Trust building was an eighteen-story building of fire-resisting construction, built of steel frame with tile fireproofing, brick curtain walls and flat tile arch floors. The partitions were hollow tile, with wood doors having thin glass panels and transoms, open elevators and stairs. The vital defect in this building consisted of wood window frames glazed with thin glass on all sides. The windows on the sides that were exposed by this fire were equipped with outside open sprinklers supplied by two elevator pumps drawing from surge tank, and four siamese steamer connections. There was a four-inch interior standpipe supplied by two small pumps connected to city main and four-inch siamese steamer connection.

The fire gained considerable headway before discovery, and soon attacked temporary frame walls at rear of a four-story brick building of

ordinary construction at the side of the Union Trust building and at the rear of the Gibson House. Notice to the employees of the Union Trust building was evidently given after fire had made progress; at least the pumps supplying the open sprinklers evidently were not started until after the window glass was broken, which prevented the maintenance of a water curtain. However, the house pumps and small surge tank, together with four-inch siamese steamer connection, would have been inadequate to supply the estimated 3,500 gallons per minute necessary for water curtain on north and west walls. The standpipe and hose equipment in this building was early found defective, valve on eighteenth floor giving way. The hose in general throughout building burst, and broke away from the couplings, seriously handicapping the firemen, who were compelled to carry their own hose from floor to floor. Early efforts of salvage corps to cover stock were defeated by rapid spread of fire, and their efforts were transferred to the direct fighting of the fire.

In the Union Trust building all north rooms overlooking the Gibson House, except the eighteenth story, were damaged. Many wood window frames were consumed, plastering destroyed, wood surface flooring burned in some places, tile partitions down, and lower web of floor arches broken off in a few places. Very few steel floor beams were exposed, and no distortion was noticeable. No damage was done to cast-iron mullions between windows. The rooms in the west side of the building show lighter damage, mostly broken glass and scorched window frames, though a few rooms were gutted. A room on the eighteenth story under west skylight, occupied as architect's office, was materially damaged. Lumber storage room on the east side of this story was not damaged. The destruction of the Gibson House and building at rear was logical, due to their light, inflammable construction.

A portion of the wood platform under which fire started may be seen in the lower right hand foreground of the frontispiece of this issue. The ruins of the Gibson House show at the left, and the division walls are easily discernible. The burned out windows in the lofty Union Trust building offer mute testimony to the folly which nullified all the virtues of this building, of such otherwise good construction, that it should have stood as a barrier to the attack of flames. Had this building been equipped with standard wired glass windows in metal frames, it would probably have been but little damaged by the fire. This fire also emphasized the need of fireproof stair and elevator enclosures, and better standpipe equipment, with standard hose and couplings in all buildings of this class.

Fire Causes.

The fires here given are selected to illustrate defects, either of construction or superintendence, in the classes of property indicated.

Lighting.

H-8335. Gas. Fire occurred in a tenant factory due to leaking gas. The shop had been closed ten minutes when an explosion occurred. It is probable that the mixture of gas and air reached such proportions that the pilot light on a Welsbach lamp ignited it.

H-8198. Electric. Employee in a leather factory hung a wet coat to dry over a cluster of electric lights on a portable stand fixture. Soon after the watchman discovered the coat ablaze.

S-13665. Electric. Fire occurred in a cotton warehouse due to a lighted 32 C. P. incandescent lamp with an inverted metal shade, which an employee had left on a bale of cloth.

Where electric lights are apt to come in contact with inflammable material they should be provided with wire guards.

Heating.

H-8308. Fireplace. Fire occurred in a hotel due to an improperly arranged fireplace, which was installed after building was built and a wood timber left under floor near the front of it. There was about four inches of cement on wire mesh and fancy tile top over the timber, but the latter became charred and finally ignited.

S-13801. Heater. A heater in a burlap bag stock plant was located in a small enclosure of plaster on wire lath and was set on a thin facing of cement laid directly on bricks between the wood floor joists. Hot ashes ignited the wood joist through cracks in the cement facing.

Heater should have been supported on metal blocks above the cement facing and a metal ash box provided.

S-13589. Hot Air Fan. Fire started in the fan casing of a hot air blower for dry loft in a tannery. It was apparently caused by a spark from fan blades striking the metal casing and igniting the oily accumulation of dust and lint on the inside of main distributing duct.

S-13609. Steam Pipes. Steam pipes in a printery ignited paper clippings.

Steam pipes should be protected with wire guards where there is a liability of inflammable material lodging upon or against them.

H-8208. Stove. Heating stove in a garage was located too near woodwork and latter was ignited.

The hazardous location of this stove should have been recognized and remedied.

Power.

S-13899. Producer Gas System. These producers were of the "pressure" type. Two fires occurred, one due to flame shooting up from charging hole of producer, and the other due to coal pot dropping while the cover was off, permitting the burning gas to escape in an upward rush, setting fire to framework and belt, and driving men from the vicinity.

Producers should be overhauled and the operating joints of coal pot and cover kept in reasonably tight condition. The weights counterbalancing coal pots should be so secured that the attendant cannot remove or adjust them, thereby inducing a premature dropping of coal pot.

H-7769. Power. Belt in sawing room of a granite cutting establishment chafed against woodwork.

Boilers.

S-13740. Flue Gas. An explosion of flue gas either in the chimney or the top of the Manning vertical boiler in the boiler house of a welt factory lifted the cover from the boiler, and flame shot out and caught the surrounding woodwork before the cover fell back in place.

H-8252. Flue. Fire occurred in foundry due to overheated flue from boiler to stack where it passed through roof. Flue had a fairly good clearance from woodwork and woodwork was protected by tin covering.

Too much care cannot be used to see that flues are fully protected and that there is ample clearance where passing through roofs or partitions.

Smoking.

S-13606. Awning on outside of a wood box factory ignited by a lighted match or cigarette dropped from a window above. A loss of $393 resulted.

H-8098. Fire occurred in a gas works due to pipe being left in workman's clothes hung in a metal closet. Fire was confined to the locker.

This common occurrence proves the virtues of a standard coat closet.

Gasolene.

H-8491. Gasolene Cleaning. A garment was being cleaned by immersion in gasolene in a dry cleaning establishment. Explosive vapors collected in room and were ignited by a hot stove.

There should be nothing in the gasolene room of a dry cleaning establishment that can possibly ignite the gasolene vapors.

S-13773. Gasolene Used by Mistake. Watchman of a machine shop filled a lighted kerosene oil lantern from a kerosene can that had been filled with gasolene by mistake.

This is a rather common and always disastrous occurrence. Gasolene should be kept in such a manner that it cannot be readily mistaken for any other fluid.

Miscellaneous.

S-13965. Gas Irons left Burning. Employee left tailoring establishment without turning off gas supply for pressing irons. Table was ignited, rubber hose burned off and gas ignited.

There should be a master valve controlling all gas utilities in charge of a responsible man. Valve should be shut whenever the building is vacated.

S-13614. Oily Material. Sawdust placed on floor of an oil store room in a building of multiple mercantile occupancy, to soak up fish oil from a leaky drum and then swept up into a pile in a corner. Spontaneous ignition resulted.

A non-inflammable absorbent should be used, where necessary, to absorb oil on floors, etc.

H-8440. Plumber's Torch. Careless use of plumber's torch while thawing out a frozen water pipe in a storage warehouse caused fire.

S-13759. Sweeping Compounds. A mop or broom containing unapproved sweeping compound was set in a corner of a closet in a mercantile building. Spontaneous ignition ensued.

Only approved sweeping compounds should be used. Other kinds may prove to be serious fire hazards.

S-13966. Sawdust Cuspidors. Fire originated in a wooden cuspidor filled with sawdust in a printing establishment, caused by a discarded cigar or cigarette stub.

Wooden cuspidors or sawdust in any cuspidors should always be strictly prohibited.

H-8512. Wooden Spittoon. A wooden box spittoon filled with leather dust in a shoe factory became ignited and fire communicated to surrounding woodwork.

Points of Interest from Fire Reports.

These notes are intended to illustrate the efficiency or inefficiency of signaling, retardant or extinguishing agencies.

Alarm Service.

S-13692. Sprinkler Alarm. Fire occurred in the paper pressing room of a cork works and was entirely extinguished by one sprinkler before being discovered by the watchman. The latter was notified by the operation of the inside electric bell and outside rotary gong.

S-13681. Sprinkler Alarm. Fire originated in an unsprinklered shed in which lumber was stored, adjacent to a woodworking plant. As fire gained headway it climbed wall of factory and broke the glass in window and opened five sprinklers. Grinnell straightway valve with outside rotary and electric connection to dwelling of nearby employee operated properly and employee was immediately awakened. He at once sent in a fire alarm from box at factory.

It was the general opinion that a serious fire would have resulted but for the timely warning given by the operation of the dry valve alarms.

H-8352. Watchman's Service. Fire occurred in the leach house of a tannery and was presumably entirely extinguished. No watchman was left on the premises. The fire rekindled and plant was severely damaged.

It is vitally necessary to have a watchman on any premises where a fire has occurred and after it has apparently been extinguished.

Automatic Sprinklers.

S-13692. Familiarity with Controlling Valves. Fire occurred in the paper pressing room of a cork works and was entirely extinguished by one sprinkler. The watchman did not know how to stop the flow of water, although there was but one controlling valve easily accessible and located on first floor.

One of the most important duties of watchman is to be familiar with the sprinkler system and the location of controlling valves.

S-13624. High Test Heads. Fire occurred in a plant manufacturing pharmaceutical preparations which contained a frame drying closet divided into seven sections, two of which contained a 300° sprinkler in each, the others being unsprinklered. There were 212° sprinklers directly over dry

closets owing to presence of steam pipes. Fire occurred in an unsprinklered section adjacent to a sprinklered section and gained some headway before opening sprinkler in adjoining compartment. A 212° sprinkler over the closets opened and also a 165° head in front of the closets. The sprinklers practically extinguished the fire.

S-11977. Unsprinklered Areas. Fire occurred in the basement of beater room of a paper mill, over a longtitudinal shaft driven by belt from engine room and which in turn drove the several beater engines. Fire was probably due to friction and burst up from the basement through the belt and stair openings. Examination after the fire showed that all the sprinklers over this main shaft in the basement were disconnected or plugged.

Without doubt, sprinklers in commission over the main line shafting would have held the fire in the basement with practically no loss.

Construction.

H-8328. Unprotected Vertical Openings. Fire occurred on first floor of a distillery in an unprotected stairway and spread rapidly to all floors of building. Had the floor openings been protected in this building it was thought the fire would never have extended beyond the first floor.

This fire clearly demonstrated the importance of making it compulsory for property owners to protect vertical openings.

Cut Offs.

H-8134. Fire Door. Fire occurred in a lumber warehouse. A three-ply fire door effectively prevented the entrance of fire to that part of plant equipped with sprinklers.

H-6742. Fire Doors. Fire occurred on the curing room floor in the storehouse of a snuff factory, designated as Building No. 2. The fire doors at Buildings No. 1 and No. 3 kept fire from entering those buildings.

The above cases show the value of good fire doors at door openings between fire sections.

S-13737. Fire Doors. A paper box factory was seriously exposed by a severe fire in an adjacent building. A brick wall separated this building from the burned building. It was parapeted two feet and tile coped. It had one opening each floor protected by good tin-clad sliding automatic fire doors which held intact and undoubtedly were the means of saving the building.

This fire demonstrated the efficiency of good party walls.

H-8535. Walls. A light well between two brick mercantile buildings consisted of metal-clad walls on frame studding. Fire which originated in one building quickly spread to the other.

Until the practice of building substantial fire-resistive party walls between buildings is general, fires will continue to spread beyond the building of origin.

Exposure.

H-8206. Iron Shutters. Fire occurred in a mercantile building of brick construction, due to an exposure fire which gained entrance through one window of a wall which was otherwise blank. Window was protected by an iron shutter, but it became heated and caused the ignition of the contents of the building.

Iron shutters and fire doors are very unreliable and are seldom successful in withstanding any amount of heat.

Housekeeping.

H-8438. Rubbish. The cellar of a department store during the holiday season became crowded with a great number of wood and paper boxes, paper and other inflammable material. A fire which originated there spread with great rapidity and building could not be saved.

Conditions of this sort are discovered and remedied where the fire department carry out a system of regular inspection.

Inside Protection.

H-8134. Hand Devices. Fire occurred in a lumber warehouse and was of small extent when discovered by watchman. By the time alarm had been given and the fire department arrived, the fire had become serious.

Had there been a cask of water or chemical extinguisher in the warehouse it might have served to extinguish the fire.

Supplies.

H-8342. Electric Pumps. Fire occurred in a storage elevator containing sulphur. Plant was protected by standpipes supplied by a 1,500-gallon two-stage centrifugal pump. At the time of the fire this pump could not be started, indicating that the electrical connections were short circuited or broken by the fire or an explosion which took place.

Fire pumps using electric power should have their source of current supply so protected that fire in the building they are designed to protect will not put them out of commission.

H-8554. Water Mains. An eight-inch wrought iron water main which fed the yard hydrant of a print, dye and bleach works, was suspended by iron hangers from ceiling in first floor of main building. Fire broke out in floor above, and in fifteen minutes the floor fell, carrying with it the main. This at once put the private hydrant out of service and cut off the supply to the sprinklers in another portion of plant.

Main supply pipes should never be installed in such an exposed and careless manner.

Water Damage.

S-13784. Fire in furniture factory demonstrated the need of giving more heed to the storage of finished goods where they will be least liable to water damage in the event of fire.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending April 1, 1913, are given, and these are compared to the results of the total sixteen-year record ending at this time.

This is the sixth year that our annual statistics have been presented in substantially the present form. During our last statistical year there has been a gratifying increase in the number of sprinklered fire reports received. The increase during the past year amounted to about forty-three per cent over last year, about thirty-three per cent over the average number of reports received during the previous three years, and about one hundred per cent over the number received during the first year covered by these statistics.

The total number of sprinkler failures, which have held at about five per cent during the two previous years, now averages 4 91 per cent. There was a decrease of about twenty per cent in the number of failures during the year just ended as compared with the previous year. The summary of these failures continues to show the same relative percentage of failures for each specified cause as those in previous summaries.

There has been a continued slight increase in the total number of fires held in check by the sprinklers, the percentage for all fires now being 31.93. The result for the past year showed an increase of about four per cent over the previous year. There has been a continued slight decrease in the number of fires practically or entirely extinguished, the percentage now being 63.16.

The percentage of fires extinguished by the operation of various number of sprinklers continues to show the same remarkable unanimity. At the present time our records show that about thirty per cent of all fires will be satisfactorily extinguished or held in check by the operation of one sprinkler; that about sixty-four per cent will be controlled by not over three heads; and that ninety per cent will be controlled by the operation of not over fifteen sprinklers.

There was a considerable decrease in the number of fires reported in dry systems during the past year.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1912-1913.		1897-1913 Inc.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Water shut off sprinklers	18	33.4	154	23.2
Generally defective equipment	2	3.7	156	23.5
Unsprinklered portions	8	14.8		
Defective heads	4	7.4		
Defective water supply or supplies	3	5.6	73	11.0
Sprinkler system crippled due to freezing	1	0.8	17	2.6
Slow operation of dry system or defective dry valve	..	..	15	2.3
Slow or defective operation of high test heads	3	5.6	12	1.8
Faulty building construction, concealed space, vertical openings, etc.	2	3.7	30	4.5
Obstruction to distribution	4	7.4	34	5.1
Hazard of occupancy too severe for average sprinkler equipment	1	0.8	35	5.3
Explosion crippled sprinkler system	1	0.8	25	3.8
Exposure or conflagration	1	0.8	61	9.2
Miscellaneous	1	0.8	25	3.8
Plugged heads	3	5.6		
Not classified	2	3.7	26	3.9
Total	54		663	

Special Classification of Fires in which Failure was Due to Water Being Shut Off Sprinklers.

	1912-1913. No. of Fires.	1897-1913 Inc. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	7	64
Water shut off before fire was out or fire re-kindled	2	27
Water shut off due to accident or repairs	5	25
Water shut off to prevent freezing	4	23
Water shut off, probably incendiary	..	7
Water shut off, leaky dry system	..	3
Water shut off, miscellaneous	..	3
Water shut off, defective gate valve	..	2
Total water shut off sprinklers	18	154

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following ten tables is given a summary of fires occurring in properties equipped with sprinklers. Number of fires reported during year, 1320, not including 464 fires where no sprinklers were opened. Total number of fires on record for years 1897 to 1913, 11,676, being a sixteen years' record.

These tables constitute a complete up-to-date revision of similar tables previously published. In addition to the fires, of which a complete record has been obtained, and which are indexed, many reports were received in the past on fires of which the record was incomplete. Such fires were used in some of the tables but not in others, and are not included in the above total.

Table No. 1.

Time of Day.

	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per cent of No. with Data Given. 1912-1913.	Per cent of No. with Data Given. 1897-1913 Inc.
6 a. m. to 6 p. m.	821	6710	63.5	59
6 p. m. to 6 a. m.	473	4679	36.5	41
Total with data given	1294	11389		
No data	26	287		
Total	1320	11676		

Table No. 2.

How Discovered.

	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per cent of No. with Data Given. 1912-1913.	Per cent of No. with Data Given. 1897-1913 Inc.
Employee	828	6973	63.5	61.9
Watchman	182	1775	14.0	15.7
Sprinkler Alarm	185	1461	14.2	13.0
Outsider	54	583	4.1	5.2
Thermostats	34	419	2.6	3.7
Automatic Pump	1	10	0.08	0.01
Supervisory System	20	54	1.5	0.5
Total with data given	1304	11275		
No data	16	401		
Total	1320	11676		

Table No. 3.

Efficiency of Alarm Service, 1912-1913.

	Satisfactory. No. of Fires.	Satisfactory. Per Cent.	Failure. No. of Fires.	Failure. Per Cent.	Total.
Watchman alone	106	89	13	11	119
Sprinkler alarm alone	215	94	14	6	229
Thermostats alone	5	83	1	17	6
Supervisory system alone	10	100	..	..	10

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	80	57*	122	15	..	..	..	..	137
Watchman and Thermostats	1	..	..	..	1	..	..	..	1
Sprinkler Alarm and Thermostats	..	..	35	..	25	10	..	..	35
Watchman, Sprinkler Alarm and Thermostats	..	7*	7	..	6	1	..	..	7
Sprinkler Alarm and Supervisory System	..	..	29	2	..	..	29	2	31
Watchman and Supervisory	1	..	..	..	..	..	1	..	1
Watchman, Sprinkler Alarm and Supervisory	7	5*	12	..	..	..	12	..	12
Sprinkler Alarm, Thermostats and Supervisory	..	..	4	..	3	1	4	..	4

Efficiency of Alarm Service, 1897-1913, Inclusive.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	1013	94.5	108	10.5	1021
Sprinkler alarm alone	993	93	76	7	1069
Thermostats alone	154	79	41	21	195

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	763	408*	1018	153	..	..	..	..	1171
Watchman and Thermostats	12	4*	..	..	15	1	..	..	16
Sprinkler Alarm and Thermostats	..	..	335	24	267	92	..	..	359
Watchman, Sprinkler Alarm and Thermostats	31	45*	69	7	56	20	..	..	76
Watchman and Supervisory	2	..	..	..	..	..	2	..	2
Sprinkler Alarm and Supervisory System	..	..	59	2	..	..	59	2	61
Watchman, Sprinkler Alarm and Supervisory System	27	14*	41	..	..	..	41	..	41
Sprinkler Alarm, Thermostats and Supervisory System	..	..	9	..	7	2	9	..	9

*These include fires where sprinkler alarm or thermostats notified the watchman.

Note.— These tables do not include fires where alarm service does or does not operate promptly if fire is at once discovered by employee, the alarm service having no bearing on such fires one way or the other.

Table No. 4.

Number of Sprinklers Operating.

No. of Sprinklers Operating	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per Cent. of Whole. 1912-1913.	Per Cent. of Whole. 1897-1913 Inc.
1	401	3973	30.9	30.2
2	227	2095	17.5	15.9
3	149	1365	11.5	10.3
4	90	965	6.9	7.3
5	57	643	4.4	4.9
6	51	539	3.9	4.1
7	34	357	2.7	2.7
8	34	348	2.7	2.6
9	23	231	1.8	1.7
10	23	217	1.8	1.6
11	24	187	1.9	1.4
12	17	192	1.3	1.5
13	5	110	0.4	0.8
14	8	128	0.6	1.0
15	12	104	0.9	0.8
16 to 20	29	366	2.2	2.8
21 to 25	24	236	1.9	1.8
26 to 30	18	173	1.4	1.3
31 to 35	8	96	0.6	0.8
36 to 40	12	87	0.9	0.7
41 to 50	10	122	0.8	0.9
51 to 75	12	168	0.9	1.3
76 to 100	8	85	0.6	0.7
Over 100 (including large number or all)	20	384	1.5	2.9
Total with data given	1296	13171		
Water shut off sprinklers	10	117		
No data	14	212		
Total	1320	13500		

Table No. 5.

Number of Sprinklers Operating.

No. of Sprinklers Operating	No. of Fires. 1897-1913 Inc.	Per Cent. of Whole 1897-1913 Inc.
1	3973	30.2
2 or less	6068	46.1
3 or less	7433	56.4
4 or less	8398	63.7
5 or less	9041	68.6
6 or less	9580	72.7
7 or less	9937	75.4
8 or less	10285	78.0
9 or less	10516	79.7
10 or less	10733	81.3
11 or less	10920	82.7
12 or less	11112	84.2

Table No. 5—Continued.

Number of Sprinklers Operating.

No. of Sprinklers Operating	No. of Fires, 1897-1913 Inc.	Per Cent. of Whole 1897-1913 Inc.
13 or less	11222	85.0
14 or less	11350	86.0
15 or less	11454	86.8
20 or less	11820	89.6
25 or less	12056	91.4
30 or less	12229	92.7
35 or less	12325	93.5
40 or less	12412	94.2
50 or less	12534	95.1
75 or less	12702	96.4
100 or less	12787	97.1
Over 100 (including large number or all)	384	2.9
Total with data given	13171	
Water shut off sprinklers	117	
No data	212	
Total	13500	

Table No. 6.

Sprinklers Opened on Wet or Dry Systems.

	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per Cent. of No. with Data Given. 1912-1913.	Per Cent. of No. with Data Given. 1897-1913 Inc.
Wet system	1110	8988	85	79.6
Dry system	198	2299	15	20.4
Total with data given	1308	11287		
Water shut off system	10	117		
No data	2	272		
Total	1320	11676		

Table No. 7.

Primary Water Supplies to Sprinklers Opened.

	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per Cent. of No. with Data Given. 1912-1913.	Per Cent. of No. with Data Given. 1897-1913 Inc.
Water Works	750	5674	57.7	50.3
Gravity Tank	310	3318	23.8	29.4
Pressure Tank	176	1620	13.5	14.4
Automatic Pump	63	657	4.8	5.8
Automatic Electric Pump	1	2	0.08	0.02
Steamer Connection	1	2	0.08	0.02
Total with data given	1301	11273		
Water shut off system	10	117		
No data	9	286		
Total	1320	11676		

Table No. 8.

Effect of Sprinklers.

	No. of Fires. 1912-1913.	No. of Fires. 1897-1913 Inc.	Per Cent. of No. with Data Given. 1912-1913.	Per Cent. of No. with Data Given. 1897-1913 Inc.
Practically or entirely extinguished fire	777	8527	58.86	63.16
Held fire in check	489	4310	37.04	31.93
Total successful	1266	12837	95.9	95.09
Unsatisfactory	54	663	4.1	4.91
Total	1320	13500		

Table No. 9.

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire.		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	36	62	20	34.5	56	96.5	2	3.5	58
Automobile and Bicycle Factories	36	66.7	15	27.8	51	94.5	3	5.5	54
Awning Factories	3	100	..	..	3	100	..	..	3
Bag Factories	2	50	2	50	4	100	..	..	4
Bakeries	17	58.6	10	34.5	27	93.1	2	6.9	29
Basket Factories	6	100	..	..	6	100	..	..	6
Bolt, Nut and Screw Works	6	75	2	25	8	100	..	..	8
Boot and Shoe Shops	305	76.8	78	19.7	383	96.5	14	3.5	397
Bottling Works	1	100	..	..	1	100	..	..	1
Braiding Mills	2	67	1	33	3	100	..	..	3
Breweries	3	75	1	25	4	100	..	..	4
Broom Factories	4	57	2	29	6	86	1	14	7
Brush Factories	6	75	2	25	8	100	..	..	8
Button Manufactories	3	100	..	..	3	100	..	..	3
Candle Factories	4	68	2	32	6	100	..	..	6
Candy Factories	29	67.5	13	30	42	97.5	1	2.5	43
Canning Works	5	71.4	1	14.3	6	85.7	1	14.3	7
Car Houses	13	39.5	15	45.5	28	85	5	15	33
Car Works	44	66.7	20	30.3	64	97	2	3	66
Carpet Mills	89	58.9	54	35.8	143	94.7	8	5.3	151
Carriage Factories	64	66.7	25	26	89	92.7	7	7.3	96
Celluloid (Pyroxylin Plastic)	46	59.8	18	23.4	64	83.2	13	16.8	77
Cement and Plaster Works	2	67	..	..	2	67	1	33	3
Cereal Mills	19	61	8	26	27	87	4	13	31
Chemical and White Lead	27	56.2	19	39.6	46	95.8	2	4.2	48
Clothing Factories	180	75	55	23	235	98	5	2	240
Coffee and Spice Mills	28	73.7	10	26.3	38	100	..	..	38
Coffin Factories	20	77	5	19.2	25	96.2	1	3.8	26
Cold Storage Plants	2	50	2	50	4	100	..	..	4
Cooperage Plants	35	54	22	34	57	88	8	12	65
Cordage Works	161	68	67	28	228	96	9	4	237
Cork Factories	3	60	..	..	3	60	2	40	5
Corset Factories	2	40	2	40	4	80	1	20	5
Cotton Ginnery	8	67	4	33	12	100	..	..	12
Cotton Mills	2299	59	1537	40	3836	99	48	1	3884
Cotton Warehouses	65	44.5	66	45.2	131	89.7	15	10.3	146
Cotton Seed Oil Mills	27	51	18	34	45	85	8	15	53
Cutlery and Hardware	5	55.5	3	33.5	8	89	1	11	9
Department Stores	190	79	41	17	231	96	9	4	240

Table No. 9—Continued.

	Extinguished Fire.		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Distilleries	4	80	1	20	5	100	..	..	5
Drug Houses	82	83	13	13	95	96	4	4	99
Dry Cleaning Establishments	1	50	1	50	2	100	..	..	2
Dyeing and Bleaching	66	50	59	44.7	125	94.7	7	5.3	132
Electrical Appliances	68	76.4	19	21 4	87	97.8	2	2.2	89
Electric Light and Power Plants	2	50	1	25	3	75	1	25	4
Elevators, Grain	13	35	12	32.5	25	67.5	12	32.5	37
Excelsior Factories	12	80	2	13.3	14	93.3	1	6.7	15
Fertilizer Plants	9	50	7	39	16	89	2	11	18
Flax and Linen Mills	12	43	16	57	28	100	..	..	28
Flour and Grist Mills	26	56.5	14	30.5	40	87	6	13	46
Forge and Smithy	8	72.7	3	27.3	11	100	..	..	11
Foundries	67	53.2	53	42	120	95.2	6	4.8	126
Furniture Factories	252	63.6	107	27	359	90.6	37	9.4	396
Garages	11	65	6	35	17	100	..	..	17
Garbage Reduction Plants	1	33.3	1	33.3	2	66.6	1	33.3	3
Gas Plants	1	100	..	..	1	100	..	..	1
Glass Works	23	70	7	21	30	91	3	9	33
Glove Factories	4	100	..	..	4	100	..	..	4
Glue Factories	2	40	1	20	3	60	2	40	5
Harness and Fancy Leather	25	80.7	6	19.3	31	100	..	..	31
Hat, Fur	24	70.6	7	20.6	31	91.2	3	8.8	34
Hat, Straw	4	44.5	5	55.5	9	100	..	..	9
Hatters Fur Manufacturing	3	50	3	50	6	100	..	..	6
Ice Plants	1	100	..	..	1	100	..	..	1
Incandescent Lamp Factories	9	69	4	31	13	100	..	..	13
Insulated Wire Factories	17	65.5	9	34.5	26	100	..	..	26
Jewelry Shops	60	84.5	8	11.3	68	95.8	3	4.2	71
Junk Shops	3	75	1	25	4	100	..	..	4
Knitting Mills, Cop Yarn	27	57.5	15	32	42	89.5	5	10.5	47
Knitting Mills, Full Process	305	64.9	143	30.4	448	95.3	22	4.7	470
Laundries	13	50	11	42.3	24	92.3	2	7.7	26
Lead Pencil Factories	8	72.7	3	27.3	11	100	..	..	11
Linseed Oil Works	9	75	3	25	12	100	..	..	12
Machine Shops	101	59.4	60	35.3	161	94.7	9	5.3	170
Match Factories	35	71.4	10	20.4	45	91.8	4	8.2	49
Mattress Factories	124	74.3	41	24.5	165	98.8	2	1.2	167
Mercantile	328	77	86	20.2	414	97.2	12	2.8	426
Metal Reduction Works	3	75	1	25	4	100	..	..	4
Metal Workers	298	62 2	155	32.4	453	94.6	26	5.4	479
Miscellaneous	128	69.2	48	26	176	95.2	9	4.8	185
Morocco Leather Shops	4	26.6	8	53.4	12	80	3	20	15
Motion Picture Theatres	2	40	3	60	5	100	..	..	5
Musical Instrument Factories	58	69	23	27.4	81	96.4	3	3.6	84
Oil Clothing Factories	6	67	3	33	9	100	..	..	9
Oilcloth and Linoleum Works	19	30.6	29	46.8	48	77 4	14	22.6	62
Oil Refineries	3	50	3	50	6	100	..	..	6
Packing House and Slaughter	22	73.5	8	26.5	30	100	..	..	30
Paint and Color Works	85	77.3	22	20	107	97.3	3	2.7	110
Paper Box and Papeterie	54	74	18	24.7	72	98.7	1	1.3	73
Paper Mills	159	50	125	39	284	89	35	11	319
Patent Leather Works	4	40	5	50	9	90	1	10	10
Picture Frame Factories	22	61	10	28	32	89	4	11	36
Plumbers' Supplies	8	72.7	3	27.3	11	100	..	..	11
Potteries	23	59	14	36	37	95	2	5	39
Printing and Lithographing	215	77.6	49	17.7	264	95.3	13	4.7	277
Pulp, Miscellaneous	5	35.7	6	42.8	11	78.5	3	21.5	14
Pulp, Soda	1	20	1	20	2	40	3	60	5
Pulp, Sulphite	12	41.3	11	38	23	79.3	6	20.7	29

Table No. 9—Continued.

	Extinguished Fire.		Held Fire in Check.		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Restaurants	4	100	..	..	4	100	..	..	4
Rice Mills	..	..	1	100	1	100	..	..	1
Rolling, Wire and Tube Works	12	44.5	14	51.8	26	96.3	1	3.7	27
Roofing Works	8	44.4	9	50	17	94.4	1	5.6	18
Rubber Cloth Factories	7	53.8	6	46.2	13	100	..	..	13
Rubber Reclaiming Works	3	43	3	43	6	86	1	14	7
Rubber Works	50	47.6	49	46.6	99	94.2	6	5.8	105
Saw and Planing Mills	54	43.9	40	32.5	94	76.4	29	23.6	123
Shirt Factories	20	77	6	23	26	100	..	..	26
Shoddy Mills	80	61	39	30	119	91	12	9	131
Silk Mills	20	59	11	29.5	31	88.5	3	11.5	34
Skin Mills	2	67	1	33	3	100	..	..	3
Soap Manufacturing	14	82.5	2	11.8	16	94.3	1	5.7	17
Stamping and Sheet Metal Works	21	55.4	12	31.6	33	87	5	13	38
Starch and Glucose Mills	8	50	3	19	11	69	5	31	16
Sticky Fly Paper Factories	3	75	1	25	4	100	..	..	4
Sugar Refineries	9	69	4	31	13	100	..	..	13
Tanneries	16	43.2	17	46	33	89.2	4	10.8	37
Tenant Manufacturing	231	72.6	75	23.6	306	96.2	12	3.8	318
Theatres	20	80	4	16	24	96	1	4	25
Tobacco Factories	27	64.3	14	33.4	41	97.7	1	2.3	42
Trunk Factories	4	67	2	33	6	100	..	..	6
Varnish Works	3	75	..	..	3	75	1	25	4
Wall Paper Factories	7	70	1	10	8	80	2	20	10
Warehouses	65	70.6	24	26.1	88	96.7	3	3.3	92
Waste and Batting Mills	137	70	52	26.5	189	96.5	7	3.5	196
Waste Paper and Rag Shops	12	60	8	40	20	100	..	..	20
Weaving Mills	60	59.4	38	37.6	98	97	3	3	101
Whip Factories	3	75	1	25	4	100	..	..	4
Window Shade Factories	6	86	..	..	6	86	1	14	7
Woodworkers, Class A*	74	52	47	33	121	85	21	15	142
Woodworkers, Class B*	69	47	62	42	131	89	16	11	147
Woodworkers, Class C*	77	60.1	44	34.4	121	94.5	7	5.5	128
Woodworkers, Class D*	49	53.8	30	33	79	86.8	12	13.2	91
Woodworkers, Class E*	41	56.1	28	38.4	69	94.5	4	5.5	73
Woodworkers, Class F*	18	64.3	7	25	25	89.3	3	10.7	28
Woodworkers, Miscellaneous	1	50	1	50	2	100	..	..	2
Woolen Mills	566	69	209	25.5	775	94.5	45	5.5	820
Wool Storehouses	17	74	5	21.7	22	95.7	1	4.3	23
Worsted Mills	21	43.8	17	35.4	38	79.2	10	20.8	48
Total Sprinkler Fires	8527	63.2	4310	31.9	12837	95.1	663	4.9	13500

***Note.**— The Woodworkers are classed as follows:

Class A. Planing Mills; interior woodwork, builders' supplies (including veneer works).

Class B. Box Factories. (Including cigar boxes.)

Class C. Miscellaneous Woodworkers. (Steam power) tenant woodworkers, (also woodworkers where there is a lack of detailed information as to class).

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning. (Wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc.).

Table No. 10.

Classification of Unsatisfactory Sprinkler Fires by Occupancies.

	Water shut off sprinklers.	Gen. defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed space, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Explosion crippled sprinkler system.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Agricultural Implements.	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Automobile and Bicycle..	1	..	..	..	..	..	..	1	..	..	1	..	..	3
Bakeries	..	1	..	..	..	..	..	..	..	..	..	1	..	2
Boot and Shoe Shops	2	2	2	..	..	1	..	..	..	2	5	..	..	14
Broom Factory	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Candy Factories	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Canning Works.....	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Car Houses.....	1	1	1	..	1	..	..	1	..	..	..	..	..	5
Car Works.....	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Carpet Mills.....	3	1	3	..	..	..	..	1	..	..	..	..	..	8
Carriage Factories	..	1	2	..	1	..	..	1	..	..	2	..	..	7
Celluloid (Pyroxylin) ...	..	..	1	1	1	..	1	..	6	2	1	..	..	13
Cement and Plaster Works	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills.....	..	2	1	..	..	..	..	..	..	1	..	..	..	4
Chemical and White Lead.	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Clothing Factories.....	2	..	1	..	..	..	1	1	..	..	..	..	..	5
Coffin Factories.....	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Cooperage Plants	1	3	..	..	..	1	..	2	..	..	1	..	..	8
Cordage Works.....	2	3	1	..	..	..	..	2	..	..	..	..	1	9
Cork Factories.....	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Cotton Mills.....	19	11	6	..	..	1	4	1	..	..	..	2	4	48
Cotton Warehouses	7	..	2	..	..	..	1	3	1	..	..	1	..	15
Cotton Seed Oil Mills	1	2	2	..	..	..	..	..	..	..	..	2	1	8
Cutlery and Hardware ...	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Department Stores.....	3	2	..	..	..	..	..	1	..	..	2	..	1	9
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	1	..	4
Dyeing and Bleaching....	2	1	1	..	..	1	..	..	..	..	1	..	1	7
Electrical Appliances	1	..	1	..	..	..	..	..	..	..	..	..	..	2
Electric Light and Power Plants.....	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Elevators, Grain.....	..	3	2	..	1	..	1	..	1	1	2	..	1	12
Excelsior Factories	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Fertilizer Plants.....	1	..	..	..	1	..	..	..	..	..	..	..	..	2
Flour and Grist Mills	..	1	..	..	..	..	1	..	..	2	2	..	..	6
Foundries.....	4	1	1	..	..	..	..	..	..	..	..	..	..	6
Furniture Factories.....	6	11	2	3	..	..	2	5	6	..	2	..	..	37
Glass Works.....	1	..	..	..	..	..	..	..	..	..	..	..	2	3
Glue Factories.....	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Hat, Fur	1	1	..	..	1	..	..	..	..	..	..	..	..	3
Jewelry Shops.....	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Knitting, Cop Yarn.....	..	1	3	..	..	..	..	..	..	1	..	..	..	5
Knitting, Full Process ...	6	8	5	1	1	..	..	..	..	1	..	..	..	22
Laundries.....	1	..	..	..	..	..	..	1	..	..	..	..	..	2
Machine Shops.....	6	2	..	..	..	..	..	..	..	1	..	..	..	9
Match Factories	2	..	..	..	..	..	..	..	1	..	..	1	..	4
Mattress Factories.....	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Mercantile ..▼.....	5	2	..	1	..	..	..	..	..	..	4	..	..	12
Metal Workers.....	10	8	2	..	..	..	..	..	..	1	2	1	2	26
Miscellaneous.....	2	1	1	..	1	..	1	..	1	..	3	1	..	11

Table No. 10—Continued.

	Water shut off sprinklers.	Gen. defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed space, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Explosion crippled sprinkler system.	Exposure or conflagration.	Miscellaneous.	Not classified.	Total.
Morocco Leather Shops	..	2	..	..	..	..	1	..	..	..	..	..	..	3
Musical Instrument Factories	..	2	..	..	..	..	..	..	..	..	1	..	..	3
Oilcloth and Linoleum Works	..	2	..	..	..	..	1	..	11	..	..	..	..	14
Paint and Color Works	1	..	1	..	..	..	1	..	..	..	..	..	..	3
Paper Box and Papeterie	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Paper Mills	4	15	3	2	..	2	1	..	..	..	2	4	2	35
Patent Leather Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Picture Frame Factories	1	2	..	..	..	..	..	1	..	..	..	..	..	4
Potteries	..	..	..	1	..	..	..	..	..	1	..	..	..	2
Printing and Lithographing	4	4	1	..	..	..	..	..	..	..	3	1	..	13
Pulp, Miscellaneous	1	1	1	..	..	..	..	..	..	..	..	..	..	3
Pulp, Soda	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Pulp, Sulphite	3	..	..	..	1	1	..	..	..	..	..	..	1	6
Rolling, Wire and Tube Works	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Roofing Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Rubber Reclaiming Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rubber Works	2	..	..	1	..	..	..	..	2	1	..	..	..	6
Saw and Planing Mills	4	6	1	..	3	1	5	2	1	..	4	..	2	29
Shoddy Mills	4	1	5	..	..	2	..	..	..	..	..	..	..	12
Silk Mills	1	1	..	..	..	..	..	..	..	1	..	..	..	3
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	..	2	1	..	1	..	..	..	..	..	1	..	..	5
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	4	..	..	..	5
Tanneries	..	..	..	2	..	..	..	..	..	..	1	..	1	4
Tenant Manufacturing	1	3	2	..	..	..	1	..	..	..	5	..	..	12
Theatres	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Tobacco Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Varnish Works	..	..	..	..	..	..	..	..	1	..	..	..	..	1
Wall Paper Factories	..	..	1	..	..	..	..	..	..	..	1	..	..	2
Warehouses	3	..	..	..	..	..	..	..	..	..	..	..	..	3
Waste and Batting Mills	..	3	1	..	..	1	..	1	..	..	..	1	..	7
Weaving Mills	1	..	1	1	..	..	..	..	..	..	..	..	..	3
Window Shade Factories	..	..	..	..	..	..	..	..	1	..	..	..	..	1
Woodworkers, Class A*	5	7	..	..	..	..	..	5	..	1	3	..	..	21
Woodworkers, Class B*	3	5	1	..	..	..	1	1	..	2	2	1	..	16
Woodworkers, Class C*	1	3	1	..	..	..	..	2	..	..	..	..	..	7
Woodworkers, Class D*	1	5	..	1	..	..	..	..	..	..	3	2	..	12
Woodworkers, Class E*	2	..	..	..	1	..	1	..	..	..	..	..	..	4
Woodworkers, Class F*	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Woolen Mills	5	14	10	1	..	1	3	..	..	..	3	4	4	45
Wool Storehouses	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Worsted Mills	2	1	2	1	..	..	..	..	..	..	..	2	2	10
Total Unsatisfactory Fires	154	156	73	17	15	12	30	34	35	25	61	25	26	663

*See detailed classification of woodworkers as given in note under Table No. 9.

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[SEAL.]

Fred'k J. Ranlett,
Notary Public.

(My commission expires *March 7*, 1913.)

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